DOCUMENT RESUME

ED 044 929		EM 008 586

AUTHOR Melton, Arthur W.; And Others
TITLE Experimental Studies of the Education of Children in a Museum of Science.
INSTITUTION American Association of Museums, Washington, D.C.
PUB DATE 36
NOTE 111p.: American Association of Museums, New Series Number 15

EDRS PRICE EDRS Price MF-$0.50 HC-$5.65
DESCRIPTORS Educational Experiments, Educational Methods, *Elementary Education, Group Discussion, Instructional Trips, Lecture, *Museums, Research Methodology, *Science Education, Teachers, Teaching Skills, Visual Learning
IDENTIFIERS *Buffalo Museum of Science, Museum Docents

ABSTRACT

The investigations reported in this monograph have to do with the relative educational effectiveness of various methods of instruction, and of attendant circumstances of the formal visits of school children to the Buffalo Museum of Science. Two broad generalizations came out of the investigations; that the effectiveness of a museum visit is subject to change through the manipulation of conditions which are under the control of the museum authorities; and that many conditions of the museum visit have various degrees of effectiveness as a function of the educational level of the visiting children, and perhaps as a function of the subject matter. Evaluation of the teaching ability of museum docents is a variable worthy of further study. The preparation for the museum visit, the function of the illustrated lecture in the museum visit, and the methods used in the experimentation are explained. The appendix contains copies of samples of the materials used in the investigations. (MF)

EXPERIMENTAL STUDIES OF THE EDUCATION OF CHILDREN IN A MUSEUM OF SCIENCE

By ARTHUR W. MELTON
Associate Professor and Chairman of the Department of Psychology in the University of Missouri

NITA GOLDBERG FELDMAN
Formerly Resident Psychologist Buffalo Museum of Science

AND

CHARLES W. MASON
Carnegie Library of Pittsburgh Formerly Resident Psychologist Buffalo Museum of Science

Studies in Museum Education

EDITED BY EDWARD S. ROBINSON
Professor of Psychology in Yale University

PUBLICATIONS OF
THE AMERICAN ASSOCIATION OF MUSEUMS
New Series, Number 15
WASHINGTON, D. C.
1936

CONTENTS

INTRODUCTION

The studies reported in the present monograph were begun in the fall of 1929 at the invitation of Mr. Chauncey J. Hamlin, President of the Buffalo Society of Natural Sciences, and of Mr. Laurence Vail Coleman, Director of the American Association of Museums. Funds for these investigations were provided by grants from the Carnegie Corporation of New York, first, to the American Association of Museums and, later, to Yale University.

Mr. Charles R. Mason, serving as staff psychologist of the Buffalo Museum of Science, did much to set up our rather elaborate program and to gain the coöperation of the public schools and of the curators and docents of the museum. Mrs. Nita Goldberg Feldman, who succeeded Mr. Mason as psychologist of the museum, served during the greater portion of our enterprise. Like Mr. Mason she played a vital part in both the strictly scientific and the executive phases of the work. Mr. Mason and Mrs. Feldman contributed to the analysis of our results as they were secured and prepared preliminary reports of various segments of the total investigation.

In its earlier stages the work was carried out under the general supervision of the editor. After 1932 this responsibility was divided with Dr. Arthur W. Melton, whose rôle became increasingly important as the studies progressed. Dr. Melton undertook the final task of reorganizing the complete findings and of rewriting the final report which constitutes the present monograph.

We owe a primary debt of gratitude to Mr. Chauncey J. Hamlin who gave us the opportunity to carry out this investigation and whose aid and encouragement was constant throughout the five-year period. We are also indebted to Mr. Laurence Vail Coleman and the American Association of Museums for supporting our work in its early stages, and to the Carnegie Corporation of New York for continued confidence and support.

We owe much to the scientific advice and practical aid given from time to time by Dr. Carlos E. Cummings, Director of the Buffalo Museum of Science, by Harold T. Clement, Curator of Education, by Professor William P. Alexander and Miss Ruth Weierheiser,

Assistant Curators of Education, by Mrs. Imogene Robertson, Curator of Malacology, and by other curators and docents of the museum. We wish also to express our appreciation of clerical help rendered by Mrs. Florence Blendinger and Miss Beatrice Goldberg.

Our studies required a long period of willing coöperation upon the part of the Buffalo public schools, and in this connection the good services of Dr. Ernest C. Hartwell, Superintendent of the Buffalo Public Schools, and of many school principals of that city, were indispensable.

Finally we wish to thank Mr. L. C. Everard, Editor of the American Association of Museums, for his aid in seeing the present manuscript through the press.

The present monograph is the third major report[1] since the beginning of our interest in this general field in 1925. The first, by the present editor, was *Behavior of the Museum Visitor, Publications of the American Association of Museums, New Series, Number 5, 1928.* The second, by Dr. Arthur W. Melton, was *Problems of Installation in Museums of Art, Publications of the American Association of Museums, New Series, Number 14, 1935.* Several additional monographs are now in process of preparation.

EDWARD S. ROBINSON.

Institute of Human Relations
Yale University
January 14, 1936

[1] A bibliography of more popular articles is given on page vi of Dr. Melton's monograph, *Problems of Installation in Museums of Art.*

Chapter I

THE USE OF THE MUSEUM FOR THE EDUCATION OF CHILDREN

The investigations reported in this monograph have to do with the relative educational effectiveness of various methods of instruction, and of other attendant circumstances of the formal visits of school children to the Buffalo Museum of Science. These studies are a part of a comprehensive research program designed to discover methods for making museums of all kinds into more effective educational centers. They may, therefore, be considered as complementary to the studies of the effectiveness of various methods of installation and labelling for the education of adult visitors in the Buffalo Museum of Science and in other similar institutions.[1] However, there is a marked difference between the studies which involve the school children and those which involve the adult visitors. The children are given a formal tour through the museum as a regular part of their school work; whereas, the majority of the adult visitors must be educated in a more casual and less personal manner. In the case of the children, the educational problem is, therefore, that of determining the best methods of direct instruction in the museum and the best methods for integrating the museum visit with the regular school work; whereas, in the case of the adult visitors, the major educational problem as currently phrased is that of determining the most effective indirect or impersonal methods for increasing attention, interest, and knowledge. Accordingly, the nature of the educational problems and of the human material in the two instances has required decidedly different methods of investigation.

The coöperation between the schools and the museums of the country has increased to a remarkable extent during the past two decades. The movement undoubtedly received considerable impetus from the so-called "visual education movement" among the educators. The museums of natural history, science, industry, or art became recognized immediately as the tool for visual education *par excellence*, since they had been devoted to a realization of that educational principle for many years. As a consequence, the museums of the country became media of visual education equal in importance to the cinema and other educational aids used in the classroom; and the practice of conducting children through museums so that they might see the things which they were being told about became a museum function of increasing importance.

Another method of using the museum materials for visual education in coöperation with the schools involved the use in the schools of special transportable exhibits which were prepared and housed in the museums. Although this practice is equal in importance to the practice of bringing children to the museums for formal instruction while face to face with the permanent museum exhibits, it has not been the subject of our investigations.[2] The experimental study of the effectiveness of the portable exhibits seemed the appropriate function of investigators directly concerned with classroom methods. On the other hand, the problems involved in the instruction of children in the museum are relatively unique, or at least highly specialized, and need special investigation by those connected directly with museums.

Although our investigations are related to the problem of the effectiveness of visual aids in education, we have made no attempt to determine by direct experimental attack the absolute effectiveness of the museum as such an aid. That is, we have not compared the knowledge held by one group of children after a two-hour tour of the museum with the knowledge held by a comparable group of children after a two-hour lecture or study of the same material in the classroom. An attempt to answer such a question, phrased in such all-or-none terms, would, we believe, be fruitless. There can be no reasonable doubt that a tour of a museum could be made less effective than the reading of a book for the same period of time. But there is also equal assurance that a tour of a museum could be made much more effective than the reading of a book. In short, the answer to such a question would certainly be that "the usefulness of the museum as a visual aid depends on the way the museum is used." Therefore, instead of attempting to answer the question whether the best possible museum tour is more effective than the best possible teaching method of the schools, we have assumed that the museum has a unique contribution to make, and we have proceeded to investigate the ways in which this contribution can be most fully realized.

In making this assumption regarding the desirability of the museum visit as an educational practice, we have no intention of indicating our acquiescence with the bolder claims of the proponents of the visual education movement. The assumption that the visual presentation of objects and relationships is *necessarily* more effective than symbolic presentation through the written or spoken word has no scientific justification and is fraught with practical dangers.[3] We accept the specific hypothesis that the museums have something unique and effective to offer when the goal is to impart ideas about the things and concepts around which our American museums have been built. We have accumulated experience to attest to the probable validity of this assumption. But there is the equally well-attested fact that the museum exhibit, or any other visual presentation, is not always, or even frequently, a *sufficient* condition for increased knowledge. The museum exhibit is a powerful tool, but has limits. There is no pre-established harmony between the ideas which the exhibit illustrates for the scholar and the ideas it occasions in the untutored onlooker. Whether the exhibit will function in its proper rôle as a visual aid will depend upon the preparation of the onlooker for the reception of the ideas, his interest in the ideas, and the type and quality of the guidance given by the docent. The first and third of these factors have been the major concern in the investigations of the museum visits of school children to be reported.

The first step in the formulation of an experimental program for determining the most effective use of the museum must be the realization that the formal and conducted museum visit is a relatively rare and hence unique educational opportunity. Children in Buffalo visit the Buffalo Museum of Science in scheduled groups only four times during their school careers, once during each of the years in which they are in the fifth, sixth, seventh, and eighth grades. This condition is representative of most school-museum coöperative projects. The topics covered during the museum visits are, therefore, much more general than they would be if the museum were used weekly by the same class. Furthermore, classes from the same grade in the schools come to the museum to learn about the same general topic throughout the year in spite of the fact that they are continually progressing, learning new things, during that year. As a consequence, some children of the fifth grade come to the museum to learn about *Birds* when they have just left the fourth grade, and others come to the museum for the same purpose when they are almost ready to move on to the sixth grade. In such a system, the museum education is inevitably supplementary, rather than an integral part of the school work, and this fact must be reflected in the methods and conditions of instruction given in the museum.

For this reason, it is conceivably worth while spending some of the time of the children in school in preparing them for the subject of the museum visit, and it is equally within reason that considerable attention be given to the problem of fixating the knowledge acquired during the visit, either by something done in the museum at the end of the visit or by something done in the schools following the visit. Even though the museum visit lasts for several hours, there is no assurance that the experience will have any permanently important effects on the child unless special preliminary and supplementary treatments of the topics of the visits are given, since there may be no effective review or integration of the subject of the museum visit in the course of the regular school curriculum.

With this approach to the problem, the major factors which need experimental investigation and comparison can be readily defined. They fall into three groups; namely, (1) the methods used for preparing the children for the subject of the museum visit, (2) the methods of instruction used during the actual visits to the museum exhibits and variations in the ability of the teacher, and (3) the methods used for reviewing or fixating the primary educational accomplishments of the museum visits. All the factors over which the museum, or the museum in coöperation with the schools, has direct control fall in one of these three categories. However, there is a fourth matter of major significance. This is the group of determinants of ability usually referred to as *individual differences*. Thus, the particular method of preparation, instruction while in the museum, or method of fixating the knowledge obtained, may depend on the educational level, intelligence level, or sex of the children. Finally, there is the subject matter of the museum visit, which must be taken into consideration. Methods of museum education, conceived broadly as including each of the first four factors may perhaps need to be adjusted to the general type of subject matter presented by the museum, i.e., whether it is in the field of art, natural history, science, or industry, and may need to be adjusted to the different types of material presented by any one of the major types of museums.

The formulation of a program of research requires a considerable amount of selection from among the many variations in educational technique available. In selecting conditions for experimental comparison we have chosen those which seemed to be of general significance for all types of museums, and those which earlier studies in museum education or in general education have emphasized. The studies of Miss Gibson and Miss Bloomberg have been invaluable for their descriptions of possible modes of variation in the techniques of instruction of children in the museum, even though they refer specifically to educational aims of the museum of art.[4] In general, it may be said that we have limited severely the number of different educational techniques which were subjected to experimental comparison, in order that we might examine thoroughly each technique in the limited time at our disposal.

Of the possible modes of variation in the circumstances of the museum visit, we have given the greatest amount of attention to the preparation in the schools for the museum visit, to the use of the illustrated lecture in the museum either as a preparation for the ideas to be presented during the visit to the exhibits or as a summary of those ideas, and to the instructional methods used by the docents while the children were in direct contact with the exhibits. Of the variables inherent in the human material with which we worked, the educational level of the children has been given major consideration. No generalization regarding the effectiveness of a particular condition of the museum visit has rested solely on the reactions of children of a particular grade to that condition. Instead, most conditions have been tested with children of the fifth, sixth, seventh, and eighth grades. Intelligence and sex have not received such general consideration in relation to the effectiveness of the conditions of the museum visit. Our early results seemed to indicate that sex differences were small, and the extent to which differences in intelligence of the children conditioned the effectiveness of certain methods could not be determined in many instances because precise intelligence records were not available. The differences in educational level, although not strictly equivalent to differences in intelligence level, have enabled us to make approximate determinations of the relation between the mental maturity of the children and the relative effectiveness of various conditions of the museum visit. Only rarely during the investigations was the subject matter of the museum visit an experimental variable. The topics of the visits of the fifth, sixth, seventh, and eighth grades were fixed by the museum authorities and in most studies the children of the different school grades received instruction on different topics.

The general plan behind the organization of our program of investigations was one which had as its aim the progressive improvement of the effectiveness of the museum visit. That is, we took as the base line from which to work the accepted methods of instruction and other conditions of the museum visit at the time we began our investigations. As each factor in the situation was investigated and the most effective condition determined, this most effective condition was incorporated as a constant feature of all further experimental studies. Thus, one of the first principles to be established was that the knowledge held by the children at the end of the museum visit could be greatly increased if some preparation for the visit, in the form of a silent reading lesson, were given in the schools before the visit. Although this principle was made more specific with regard to the method of preparation and the time of preparation as a result of later investigations, some form of preparation in the schools was thereafter used as a standard feature of every new experiment. Therefore, each year during the five years of the investigation the "accepted" way of conducting the education of the children in the museum changed. Each change presumably made the "accepted" condition more effective. In view of this progressive improvement in our basic comparison condition, it should not be surprising that the absolute changes in test scores produced by new alterations in the circumstances of the visit were often small. If, at the end of the five years of continuous alteration of the circumstances of the visit in accordance with our experimental findings, we had compared the final museum practice with the practice at the time our investigations were begun, surely a large absolute difference in the effectiveness of the "before" and "after" would have been noted.

The extent of the difference between the final "accepted" method and the "accepted" method during our first year of work may be roughly indicated by a statement of those two sets of conditions. At the time we began our investigations, the children attended the museum without having had any preparation in the schools. On arrival at the museum, the children were taken to the lecture room for an illustrated lecture which lasted about 30 minutes. Following the lecture, four groups were made from the one large group and each group was conducted on a lecture tour through four of the museum halls. During these tours a pure lecture method was generally used by the docents. Following this, the children were returned to the schools and, so far as could be determined, no formal review of the material covered in the museum was ever given. The children of the fifth, sixth, seventh, and eighth grades were treated in essentially the same manner, the only variation being the topic or material studied.

At the conclusion of our series of investigations, the children of each school grade were treated in a manner which had been shown to be best fitted to children of their educational level. We cannot attempt to trace at this time the exact methods used with each of the four grades. It will suffice to indicate that children of all grades were given preparation in the schools before they entered the museum. This preparation was usually given one day before the museum visit, since this interval had been shown to be more profitable than the longer interval of a week, which had been used as a result of our earliest investigations. Furthermore, this preparation was always in the form of a silent reading lesson and a test on the silent reading lesson, and appropriate illustrative material was used whenever available. The introductory illustrated lecture had been reduced from 30 minutes to 15 minutes, and it was sometimes eliminated altogether, so that it might be replaced by a summary lecture of the same length. In the museum halls the children of the fifth grade were taught by means of lectures, the children of the sixth grade were taught by means of a game device which demanded some initiative for the answering of questions about the exhibits, and children of the seventh and eighth grades were instructed by means of a discussion method which was likewise designed to create an active attitude toward the exhibits. Finally, some effort was made by the museum to summarize the principal ideas presented during the visit by means of a summarizing illustrated lecture, particularly when the discussion method had been used in the museum halls. On the basis of other evidence it was known that some form of explicit review, either in the museum or in the schools after the visit, aided in fixating and prolonging the effects of the museum visit, and the museum had adopted the information test as an effective method for aiding the fixation of the knowledge gained during the visit.

In the chapters which follow, these experimental findings have not been organized in a chronological order. Many times during the course of our studies we were forced to back-track to some earlier problem and collect new data as a check on our previous conclusions. Consequently, the most satisfactory mode of presentation seems to be one which organizes our experimental data in terms of the specific problems involved. The first of the succeeding chapters is concerned with a general discussion of our methods of investigation. The importance of this chapter cannot be over-emphasized, since it reveals a number of the statistical and experimental dangers inherent in studies of the type with which we have been concerned.

References will frequently be made to the Appendix of this monograph. The number of different lectures and special testing or teaching forms used in these investigations was so great that the presentation of the specific materials together with the results from each experiment has been deemed unnecessary and productive only of confusion. Accordingly, we have presented in the Appendix two complete sets of the forms and lectures used with the children. These sets are representative of those used with children of the fifth and sixth grades and of those used with the seventh and eighth grades.

NOTES

[1] The reader is referred to A. W. Melton, *Problems of Installation in Museums of Art*, Publ. Am. Assoc. Museums, N.S. 14, 1935, for a detailed presentation of this aspect of our studies of museum education. The treatment is not restricted to museums of art.

[2] An exploratory study of the loan exhibits of the Buffalo Museum of Science has been made, but it is not reported in this monograph. However, those interested in this aspect of the coöperative work of schools and museums will note the potential significance of these exhibits with reference to the experimental conclusions of Chapter III.

[3] See F. N. Freeman, *Visual Education*, Univ. of Chicago Press, 1924, for a lucid and forceful presentation of the point of view adopted in these studies.

[4] K. Gibson, An Experiment in Measuring Results of Fifth Grade Class Visits to an Art Museum, *School and Society*, 1925, 21, 658–662. M. Bloomberg, *An Experiment in Museum Education*, Publ. Am. Assoc. Museums, N.S. #8, 1929.

Chapter II

THE METHODS OF EXPERIMENTATION

The basic problem attacked in the investigations to be reported is that of the most effective methods for use in making a museum of science an instrument for mass education of children at the elementary school level. Our methods of experimentation as well as the specific educational practices examined were, therefore, adjusted to the solution of this relatively specific problem and to the traditional practices in the Buffalo Museum of Science. As will be apparent in the following discussion of techniques and experimental controls, our methods of experimentation could frequently have been improved upon if we had discarded certain traditional ways of handling the children in the museum, or if we had made a vigorous attempt to encroach more on the time of the schools. However, these other ways of conducting the experiments would have too often made our experiments more or less artificial in character, or at least unlike the situation usually prevailing when attempts are made to coördinate the activities of school and museum. As a compensation for the less exact experimental controls, we have repeated most of our experiments and have given credence only to those principles which represent the consensus of experimental results.

The method of experimentation used throughout has been a variation of the method of control groups. That is, a group of children were prepared for the museum visit in a certain way, taken through the museum and instructed there in a certain way, and finally tested for the amount of information they retained. Another group of children, which was presumably comparable to the first group, was then given the same treatment except for the alteration of one feature of the entire plan of instruction. The average scores of the two groups on the information test were used to determine the relative effectiveness of the altered phase of the plan of instruction. The same test was administered to the two groups, and the interval of time following the museum visit before it was administered remained constant. Obviously, the adequacy of this experimental technique depended upon

(1) keeping all aspects of the methods of instructing the children constant from group to group, except for the experimental change in which we were interested, and on (2) having the groups of children who served as subjects equivalent in every important respect. This second requisite means that the groups had to be equivalent with respect to every factor which might influence the scores on the information test given at the end of the visit. The first requisite was not difficult to fulfill; the second requisite was the one which determined—together with the limitations imposed by the schools and the museum—our particular modification of the more usual method of control groups.

The most common method for selecting equivalent groups of subjects for such experiments is to select the members of the groups at random from among a more or less homogeneous population such as that represented by fifth grade children. In this case, the equivalence of the two or more groups used in the experiment is a function of the number of children included in the groups, and the possibility that an obtained difference between the test scores of the groups resulted from chance sampling errors may be estimated by the well known statistical formula for the Probable Error of the Difference: $\sqrt{P.E.^2_A + P.E.^2_B}$ where $P.E._A$ is the Probable Error of the Mean of Group A and $P.E._B$ is the Probable Error of the Mean of Group B.[1] If the value determined by this formula is less than one-fourth the amount of the difference between the means of Group A and Group B, the experimenter can be practically certain that the difference was not due to chance sampling errors. That is, the difference may be attributed to the experimental change in the method of instruction, provided, of course, that all other factors in the circumstances of the museum visit were held constant. As a refinement of this method, it is possible to match individuals assigned to the two or more experimental groups in terms of some variable, such as intelligence, which is known to correlate with the obtained test scores. This method reduces the opportunity for the occurrence of chance sampling errors, because one important variable is held constant experimentally. This *matched group method* permits a correction of the formula given above which reduces the size of the obtained Probable Error of the Difference, and thus increases the designated degree of reliability of the obtained difference.[2]

Neither of these methods for selecting comparable groups of subjects has been used in our experiments, although the principle involved in the method of matching individual subjects has been applied in part in order to decrease the possibility of marked sampling errors, and the estimates of the reliability of obtained differences have been secured by the application of the simple formula cited above. The reason for this failure to follow the more traditional methods is obvious from a consideration of the school-museum arrangements. Individual children could not be selected at random for inclusion in the various experimental groups because the children always came to the museum by schools, i.e., all the fifth grade children of a particular school in Buffalo were brought to the museum at one time. Furthermore, the children had to be conducted through the museum in units no smaller than a single class of about thirty children. As a consequence, it was necessary to consider the *school* and the *class* as our unit for sampling and the attempt to equate experimental groups of children resolved itself into an attempt to match the classes of children which were included in the experimental groups. This method may be called the *method of parallel groups* to distinguish it from the method of matched groups in which the individual subject is the unit for sampling.

Since the method of parallel groups demands that classes of children rather than individual children be matched, our first efforts toward a more adequate method for these investigations were aimed toward the determination of the significant ways in which classes from different schools in Buffalo differed from one another. Analyses of other studies and specific methodological studies of our own led to the delimitation of the following three important respects in which experimental groups of subjects used in these studies needed to be matched.

(1) *Differences in educational level:* Perhaps the most important factor which must be considered in equating two groups of children is that of educational level. Intelligence measurements may be used, but educational ratings, as represented in the Educational Quotient (E.Q.), are more to the point.[3] In matching the groups of children such E.Q. measurements reflect not only ability but also the amount of schooling and the rate of progress in school as determined by language difficulties, motivation, etc. In our studies, the E.Q. ratings were used because the E.Q. records of the Buffalo Public School System were far more complete than the I.Q. records. The E.Q. ratings of individual children were obtainable during the first three years of our studies; and thereafter, due to curtailment of the activities of the

Psychological Department of the schools, only the ratings of high (X), medium (Y), and low (Z) scholastic achievement were obtainable for the classes. When E.Q. measurements were obtainable, they had been based on the Public School Achievement Test or the New Stanford Achievement Test.

A modicum of control of the educational levels of the children included in the several experimental groups was, of course, obtained by limiting the classes assigned to the various experimental groups to those which were of the same school grade. That is, all the children who served in a particular experiment were selected from those in grade 5A, or from those in grade 5B, etc. When children of different grades were used in the same experiment, the matched groups were made up separately for the different grades and all statistical summaries of the test scores made by the children who served under the various conditions have been made separately for the different grades.

As a further precaution, an attempt was made to equalize the groups with respect to the time during the year at which the children attended the museum. An attempt to equate large groups of children in terms of their educational age would be patently subject to gross errors if no attention were paid to the time during the school term at which the children attended the museum. It is as serious an error to compare the performance of a group of children that had just entered grade 5A with the performance of a group just ready to pass on to grade 5B, as it is to compare the performance of 5A children late in the term with 5B children early in the term. We attempted, therefore, to pair the groups of children so as to rule out such time differences within any grade level.

However, these controls of the factor of educational achievement could not be made entirely adequate. There were differences between the schools of Buffalo with respect to the average E.Q. of the children included in the several grades. For example, one school had five classes in grade 5A, three of them including children of average E.Q., one including children of high E.Q., and one including children of low E.Q.; whereas, another school had five classes and the same number of children in its grade 5A, but two of the classes included children of average E.Q., two included children of high E.Q., and one included children of low E.Q. In view of the fact that each school—with its several classes—had to be treated as a unit in our studies, our major concern was with the problem of equating the *schools* included in the various experimental groups in terms of the average E.Q. rating of the children therein.

In the first studies we had access to the E.Q. ratings of each child in the schools of Buffalo. From these records we obtained the median E.Q. of the children in each of the schools of the city, and the schools included in the several experimental groups were matched in terms of this median E.Q. rating. Later, when the E.Q. records were not obtainable for each child, we either established the rating of the children in a school on the basis of estimates obtained during the last year when E.Q. measurements were made, or we merely estimated the probable E.Q. level of the children in the school on the basis of the past E.Q. rank of the school among all the schools of Buffalo. Even though the more exact E.Q. measurements had been abandoned, some of the schools still retained their system of segregating the children of high, medium, and low ability in each of the grades, and these were used as aids in estimating the comparability of schools. In the most extensive experiment of the entire group to be reported—the experiment on the relative effectiveness of the lecture and discussion methods in the museum halls—all the children included in the X, Y, Z, and unselected classes of the seventh and eighth grades of Buffalo were used, and in this case it was possible to use a method of random sampling of *classes* within each ability classification in an effort to control for systematic differences in the abilities of the subjects included in the different experimental groups.

(2) *Nationality differences:* In the first studies at the Buffalo Museum of Science it was discovered that classes which were composed almost entirely of Italian or Polish children made significantly lower scores on the information test than the classes which were made up almost entirely of American children. The average test scores of American, Italian, Polish, and mixed groups during one of the early studies are given in Table I. The information test was given at the end of the museum visit. This visit had been conducted either by the method of docent lectures or by the game card method, and the test was of the true-false type. The superiority of the children who came from the predominantly American schools in Buffalo is evident, since in every instance this group made the highest average score on the test.

Whether these differences were a function of nationality *per se* cannot be stated. It is probable that there were differences in the average E.Q. ratings of the various groups and that these were correlated with the differences in nationality. But it was also considered within reason that the whole of these differences between the scores made by the various nationality groups on the museum test could not be explained in terms of differences in the average E.Q.'s of the groups. For example, the difference between the nationalities in performance on the information test may have reflected language difficulties which were not completely accounted for in the E.Q. ratings of the groups.

TABLE I

Differences in the Museum Test Scores Made by Classes Predominantly Composed of American, Polish, and Italian Children

Teaching Method Used in the Museum	Polish Classes	Italian Classes	American Classes	Mixed Classes
		Fifth Grade Children		
30-Minute Lecture and Docent Lectures	8.62 ± .21 *N = 270*	5.66 ± .44 *N = 128*	9.35 ± .27 *N = 235*	8.08 ± .40 *N = 133*
30-Minute Lecture and Game Cards	6.73 ± .31 *N = 270*	7.41 ± .24 *N = 318*	9.18 ± .30 *N = 237*	8.22 ± .48 *N = 101*
15-Minute Lecture and Docent Lectures	8.46 ± .37 *N = 199*	9.14 ± .33 *N = 161*	11.28 ± .32 *N = 185*	9.42 ± .36 *N = 177*
15-Minute Lecture and Game Cards	6.50 ± .28 *N = 297*	7.07 ± .39 *N = 241*	9.76 ± .26 *N = 313*	7.98 ± .27 *N = 240*
		Sixth Grade Children		
30-Minute Lecture and Docent Lectures	6.79 ± .38 *N = 159*	7.15 ± .24 *N = 314*	8.47 ± .29 *N = 194*	5.44 ± .45 *N = 111*
30-Minute Lecture and Game Cards	6.50 ± .27 *N = 308*	7.37 ± .26 *N = 275*	9.83 ± .27 *N = 214*	5.61 ± .55 *N = 85*
15-Minute Lecture and Docent Lectures	6.66 ± .36 *N = 141*	7.83 ± .41 *N = 81*	9.18 ± .27 *N = 197*	6.14 ± .48 *N = 109*
15-Minute Lecture and Game Cards	6.49 ± .34 *N = 159*	7.63 ± .32 *N = 188*	10.27 ± .27 *N = 303*	5.35 ± .29 *N = 284*

N = Number of Children Tested.

Therefore, it was deemed advisable to equate the groups of children used in our experiments in terms of the nationalities represented.

It was not possible to equate the experimental groups in terms of nationalities by the simple process of eliminating the children of foreign-born parents from consideration, since this group included 42 per cent of all the public school children in Buffalo,[4] and these children were not completely segregated into certain schools. Instead, it was necessary to include equal numbers of Polish, Italian, and American children in each of our experimental groups at the same time that we held constant by the matching procedure the educational level of the groups. Fortunately, this procedure was simplified by the fact that a great many of the schools in Buffalo serve children predominantly of the Polish or Italian groups. These schools may be located with considerable accuracy in certain sections of the city of Buffalo, so that it was possible to equate experimental groups in terms of nationality by selecting schools for each group so that the groups represented the same sections of the city. A sample of the schedules which were

TABLE II

Sample Schedule Used in the Attempt to Equate the Children Included in Four Experimental Groups in Terms of Educational Level and Cultural Background

Teaching Method I	Teaching Method II	Teaching Method III	Teaching Method IV
4 Schools of Average E.Q. *Location:* North Buffalo South Buffalo East Buffalo West Buffalo	4 Schools of Average E.Q. *Location:* North Buffalo South Buffalo East Buffalo West Buffalo	4 Schools of Average E.Q. *Location:* North Buffalo South Buffalo East Buffalo West Buffalo	4 Schools of Average E.Q. *Location:* North Buffalo South Buffalo East Buffalo West Buffalo
1 School of High E.Q. *Location:* West Buffalo	1 School of High E.Q. *Location:* West Buffalo	1 School of High E.Q. *Location:* West Buffalo	1 School of High E.Q. *Location:* West Buffalo
1 School of Low E.Q. *Location:* South Buffalo	1 School of Low E.Q. *Location:* South Buffalo	1 School of Low E.Q. *Location:* South Buffalo	1 School of Low E.Q. *Location:* South Buffalo

drawn up for each experiment in an attempt to control for E.Q. differences and for the possibility of nationality differences is given in Table II. Four schools of average E.Q. ratings were included in each of the experimental groups in order that all the major sections of Buffalo would be represented. If, in the group of four schools of medium E.Q. rating, one school from *south* Buffalo had a relatively low rating in Condition I of an experiment, other schools from south Buffalo with low E.Q. ratings were selected for inclusion in the groups which served under each of the other conditions of the experiment. Likewise, one school with a very high E.Q. rating and one school with a very low E.Q. rating were included in each of the experimental groups, always with the location of the schools in the city as a constant. We rarely used less than six schools in each experimental condition; the number was frequently as great as ten. In this latter case, the additional schools were used to increase the size of the groups with average, high, or low E.Q. ratings, but always with the location of the schools included in various conditions held constant in the way demonstrated in Table II.

(3) *Differences in the teaching ability of the museum docents:* Each of our investigations was so extensive, in terms of the number of children tested under each experimental condition, that the use of more than one museum teacher was necessary. As an additional factor which determined our use of several docents, there was the custom in the Buffalo Museum of Science of dividing the children from a single school into four groups at the time of the tour through the museum halls, each group being put under the guidance of a docent. This situation required an experimental control of the human factor in the instruction of each of the experimental groups. It was suspected at the beginning of our studies, and later confirmed (see Chapter VI), that the docents provided by the museum varied in teaching ability and in knowledge of the material to be taught. The proof of these individual differences in teaching ability, which rested on a comparison of the scores of large equivalent groups of children who had been taught by the various docents, was not obtained until late in the program of studies. Therefore, in our studies, we were not able to select four docents of known equal teaching ability from among those employed by the museum. We were forced to depend upon a system whereby the museum docents used to teach the children under any one experimental condition were also used to teach the children under every other experimental condition in the same investigation. This control was neither positive nor precise, because it was not advisable to disrupt the established routine of the museum procedure in handling the masses of children. Consequently, one docent might be used to teach the children under experimental conditions *A*, *B*, and *C*, but not in *D*; whereas, another docent might be used in experimental conditions *A*, *B*, and *D*, but not in *C*. However, extreme differences in the quality of the teaching received by the different groups of children were guarded against by having the children of each school taught by at least four different docents, as previously described. We were thus

assured that any one docent's ability would not figure too greatly in the performance of the children of any one school or of any one experimental condition.

These controls, which we instituted in an endeavor to equalize our experimental groups with respect to every factor other than the method of museum instruction being investigated, cannot be considered completely adequate. For this reason, the estimations of the statistical reliability of any obtained difference between two average test scores must be accepted with caution. Such estimates assume that there were no constant differences between the experimental groups except with respect to the experimental variable. Therefore, we have placed the greatest emphasis upon the concordance of several experiments with regard to the effectiveness of a particular method of instruction. If the repetition of an experiment with the same school grades revealed no effect, or a negative effect, of a teaching method which had previously been found to have a positive effect, it has been assumed that one or more of the three factors mentioned above were inadequately controlled in one or the other of the experiments. In such cases, definite recommendations regarding the teaching method must be withheld until the weight of evidence is distinctly for a positive or a negative effect. On the other hand, if the repetition of an experiment yielded consistent results, then this fact has been considered as somewhat more important than the demonstration of the statistical reliability of the result of either of the two studies.

METHODS USED IN MEASURING THE EFFECT OF THE MUSEUM VISIT

All the conclusions as to the relative effectiveness of methods of museum instruction, of methods of preparing pupils for the museum visit, or of the teaching of different museum docents, rest upon measurements of the amount of information possessed by the pupils after the museum visit. That is, the basis for comparing the conditions tested in our studies is the ability or inability of the pupils to answer questions about the objects and ideas presented in the museum. It is obvious that a considerable proportion of the questions which were asked at the end of the visits concerned with subjects such as *Birds*, *Vertebrates*, *Earth Science*, or the *Story of Man*—these were the major subjects of study for pupils of the fifth, sixth, seventh, and eighth grades, respectively—probably could have been answered correctly by the pupils even though no museum visit had occurred. Therefore, we have been forced to judge the relative effectiveness of any two ways of conducting the museum visit in terms of the *relative* amounts of information possessed by the groups of pupils instructed in the different ways. The absolute scores of the pupils on the information test do not represent how much was learned during the museum visit. They represent both prior knowledge and knowledge gained during the visit. Although it would have been of some value to have determined the absolute increment in knowledge which resulted from the museum visit, it was not feasible to subject the pupils to prior examination.

The information tests have been predominantly of the "objective" type. In the first study in Buffalo, an attempt was made to introduce the essay type of examination in conjunction with the objective type, but this practice was discontinued immediately. The essay type examination not only required that more of the short time for the museum visit be spent in the taking of the test, but it also increased the time necessary for grading to such an extent as to reduce the number of pupils that could be included in our experiments. Moreover, the evidence from numerous investigations in the field of educational psychology clearly indicates the adequacy, if not the superiority, of the objective type examination.[5]

The objective examinations have been either of the true-false type or the multiple-choice type. (See Appendix, pages 87–88). In the first, a statement is made and the pupil merely indicates whether he considers it true or false. In the completion or multiple-choice test, the pupil is required to make a sentence into a true statement by inserting into it one of the four words or phrases which are provided as alternatives. For the most part, the true-false tests were used whenever the information tests were given in the museum immediately after the tour of the halls and the multiple-choice tests were used whenever a re-test on the same material was given in the schools after the visit. However, the investigations carried on in the final year of the program utilized the multiple-choice test for the examination in the museum.

The length of the multiple-choice test and true-false test varied from 20 to 50 items, but the majority of the tests were composed of from 20 to 30 items. The children were permitted only 10 minutes for the test, and this provision prevented a massing of perfect scores on the tests, which might have occurred if there had been a longer or unlimited test period. In using a test with so few items, it was recognized that the scores obtained were not adequate for the differentiation of individuals, but that they could serve only for comparisons of large groups of pupils. This limitation of the use of the test scores became apparent when, in the course of our first two years of study, we determined the correlation between individual scores on the objective tests and individual E.Q. ratings. For example, with the sixteen groups of fifth grade pupils, whose average scores have been given in Table I, the correlation coefficients ranged between .44 ± .04 and .03 ± .04.[6] With the sixth grade pupils, whose averages are shown in the same table, the *r's* ranged between .56 ± .03 and .10 ± .04. These correlation coefficients indicate the presence of a low, or at most, moderate, relationship between the educational ability of the children, as measured by standard tests, and the amount known at the end of the museum visit, as measured by our test. The tests used in this study were composed of 20 true-false statements and were administered at the museum immediately after the visit. In the following year, correlations between the scores on a 20-item multiple-choice test, which was administered in the schools one week after the museum visit, and the E.Q. ratings of the pupils revealed no higher degree of concomitant variation of these two variables.

A direct measure of the reliability of our tests could have been obtained, but this has not been done. The presentation of reliability coefficients for each of the information tests used during our studies would serve no useful purpose. The conditions under which the experiments were conducted prevented serious attempts to develop, by preliminary study, tests which were highly reliable for the determination of individual differences.

Every feasible means was used in an effort to make the tests adequate instruments for the measurement of the amount of knowledge possessed by the children at the end of the museum visit. Since there was a limitation as to the amount of time that could be spent in this way, it was necessary that we *sample* the ability of the children to reproduce the ideas presented during the visit. The validity of each test rests, therefore, on the adequacy of this sample. In order to free the tests from "trick" or unimportant questions, and from excessive emphasis on certain facts which might not have been emphasized by the docents during the tour of the museum halls, the following method of constructing the tests was devised and used throughout the investigations. First, a thorough study of the materials presented in the

TABLE III

Apportionment of Lecture Topics and Test Questions on the Story of Man

A. *Progress of Man*		50%
1. General Statements	6%	
2. Man's Needs	4%	
3. Fire	4%	
4. Agriculture	8%	
5. Pottery	2%	
6. Commerce	4%	
7. Manufacturing	2%	
8. Weaving	2%	
9. Printing	2%	
10. Weapons	4%	
11. Beliefs	2%	
12. Writing	6%	
13. Language	2%	
14. Tools	2%	
B. *Characteristics of Individual Tribes*		30%
1. Indians of Northern and Southern California	2%	
2. Iroquois	2%	
3. Sioux	4%	
4. Hopi	2%	
5. Pueblos	2%	
6. Algonquins	2%	
7. Sand Paintings	2%	
8. Waiwai	2%	
9. Yaghans	2%	
10. Zulus	2%	
11. Mt. Lapps	4%	
12. Copper River Eskimos	4%	
C. *Early Civilization*		10%
1. Philippine	2%	
2. Mayan	4%	
3. Egyptian	4%	
D. *Comparison of Cultures of Eastern and Western Hemisphere*		2%
E. *Cro-Magnon Man*		4%
F. *Old Stone Age and New*		4%
1. Animals	2%	
2. Names	2%	

formal lectures and in the lectures in the museum halls was made and the results were summarized in a table which showed the sub-topics treated under the general topic, and the relative amounts of time spent on each sub-topic. For this purpose, we used stenographic reports of the docents' lectures, and of the formal lectures given in the auditorium. There was, of course, some variation in the lectures given by different docents, so that only those sub-topics which were a regular part of the lectures of all the docents were accepted as material with which the children could be expected to be familiar. When these surveys were complete, a "table of specifications" for the information test was devised. An example of such a schedule, in this case pertinent to the 50-item multiple-choice test on the *Story of Man*, is given in Table III. The test questions were then apportioned to the various sub-topics according to the schedule. The formal lecture and the typical docent lecture, on the basis of which the "table of specifications" in Table III was constructed, may be found in the Appendix, pages 91–102. Two tests which were constructed with this schedule as the base are given in the Appendix, pages 102–106.

TABLE IV

Average Scores of Children on Multiple-Choice Tests Given in the Schools One Week after the Museum Visit

Subject of the Museum Visit	Grade	No Test in the Museum			Test in the Museum			Difference / P.E.diff.*
		N	Average	P.E.av.	N	Average	P.E.av.	
Invertebrates	7th	520	10.97	.088	370	10.75	.094	1.71
	8th	463	11.95	.088	541	11.68	.081	2.25
	7th–8th	327	11.10	.115	239	12.62	.142	8.31
Birds	5th	567	15.40	.081	604	15.62	.074	1.09
Vertebrates	6th	672	15.88	.054	580	16.65	.054	10.13

N = Number of Children Tested.

* The difference must be 4 times the P.E.diff. if it is to be considered greater than could be accounted for by chance alone.

The tests which were given to the children at the end of the museum visit may have served not only to measure the effects of the visit but also to fixate the effects of the visit. In five different investigations of other factors in the museum situation, this possibility was tested. In each study, one group of children was given the test in the museum and a second test in the schools one week later, and another group of children was given the delayed test in the schools, but was not given the test in the museum. Except for this difference, the entire museum visits, and the preliminary preparations, of the two groups were the same. In Table IV are presented the average scores of the several groups of children subjected to these two conditions. It is clear that the tests given in the museum were not always productive of higher scores on the delayed test, so that it must be concluded that the tests were not necessarily a teaching aid. On the other hand, there are no instances in which the no-test group was significantly superior on the delayed test, and there are two instances in which the test group was decidedly superior to the no-test group. The conservative conclusion must be that the test at the end of the museum visit will not hinder the performance of the children on a delayed test, and it may be a valuable aid to the fixation and retention of the newly acquired knowledge. The fact that all of the tests in the museum were of the true-false type may account for the equivocal results of these studies, since it is well known that true-false tests sometimes fixate erroneous ideas.[5] This is particularly likely to be the case when there is no organized effort to review and correct the answers given to the questions. To the best of our knowledge, such reviews and corrections were not practiced by the teachers in the schools after the museum visit.

NOTES

[1] The Probable Error of the Mean of a group of scores is obtained by the formula: $.6745 \frac{\text{Standard Deviation}}{\sqrt{N}}$. N is the number of observations included in the group, and the Standard Deviation is the root mean square deviation of the individual measures from the average.

[2] See E. F. Lindquist, The Significance of a Difference Between "Matched" Groups, *J. Educ. Psychol.*, 1931, 22, pp. 197–204; M. Ezekiel, "Students" Method of Measuring the Significance of a Difference Between Matched Groups, *J. Educ. Psychol.*, 1932, 23, pp. 446–450; E. F. Lindquist, A Further Note on the Significance of a Difference Between the Means of Matched Groups, *J. Educ. Psychol.*, 1933, 24, pp. 67–69; and M. Ezekiel, A Reply to Dr. Lindquist's "Further Note" on Matched Groups, *J. Educ. Psychol.*, 1933, 24, pp. 306–309.

[3] The Educational Quotient (E.Q.) is a measure of the educational achievement of the child relative to the achievement to be expected for one of his chronological age. It is the ratio of educational age, as tested, to chronological age, as measured from the birth date.

[4] This percentage is based on the only available data. In 1933–34 there were 71,425 children in the elementary public schools of the city of Buffalo, and of this group only 41,091 children (58 per cent) had American-born fathers. Among the 30,334 children of foreign-born fathers, 11,930 were children of Italian-born fathers, and 8,227 were children of Polish-born fathers.

[5] For summaries of the advantages, uses, and methods of construction of objective tests see: L. B. Kinney and A. C. Eurich, A Summary of Investigations Comparing Different Types of Tests, *School and Society*, 1932, 36, pp. 540–544; L. B. Kinney and A. C. Eurich, Studies of the True-False Examination, *Psychol. Bulletin*, 1933, 30, pp. 505–517.

[6] The correlation coefficient, r, expresses the degree of uniformity and the direction of the relationship between two variables. A negative coefficient indicates an inverse relationship, and a positive coefficient indicates a direct relationship. The limiting values of the coefficient are -1.00 and $+1.00$, and a coefficient of 0.00 indicates the absence of any relationship between the variables. In general, values of r up to ± 0.50 indicate a very slight to moderate relationship, and values above ± 0.90 indicate a very marked concomitant variation. A relatively non-technical discussion of the correlation coefficient may be found in C. L. Hull, *Aptitude Testing*, World Book Co., 1928, pp. 9–13, 226–253, 268–276.

The Probable Errors of the Pearson product-moment correlation coefficients cited in the text have been obtained by the formula:

$$\text{P. E.}_r = \frac{.6745\,(1-r^2)}{\sqrt{N}}$$

An r must be four times the size of its P.E. if it is to be considered as indicative of a significant relationship.

Chapter III

THE PREPARATION FOR THE MUSEUM VISIT

One of the first problems to receive attention in the studies at the Buffalo Museum of Science was that of the preparation which should be given the children before their visit to the museum. The importance of this problem becomes evident when it is realized that, on the scale on which museum visitation is usually conducted, it is impossible to integrate perfectly the subject matter given during the visits and the subject matter given in the schools at or near the time of the visits. This difficulty was prominent in the case of the Buffalo Museum of Science, since it was impossible to treat each school class in accordance with its particular needs and preparation. Instead, the children of the sixth grade, for example, were given a lesson on vertebrates at the museum no matter whether they happened to make the visit in September, December, or May, and no matter whether they had reached a point in their course in biology which made the treatment of vertebrates appropriate. In view of this, it seemed that a special preparation for the museum visit which would be given in the schools sometime before the visit might alleviate some of the disadvantages of this lack of integration, and therefore deserved investigation.

The experiments which we have performed have been concerned with three separable aspects of the question of the advisability of preparation in the schools. These questions are: (1) Is any type of preparation effective in increasing the value of the museum visit? (2) Are certain types of preparation for the museum visit more effective than others? (3) Is there an optimal time relationship between the preparation in the school and the museum visit? The answer to the first question has been consistently in the affirmative, in the sense that throughout all the variations in the conditions of the school preparation for the visit, some preparation has always been superior to no preparation. As a consequence of this, presentation of the experiments will be phrased in terms of the comparative effectiveness of the particular circumstances of the preparation in the school.

EXPERIMENT I: THE SILENT READING LESSON AND TEST AS PREPARATION FOR THE MUSEUM VISIT

The first type of preparation studied was the silent reading lesson. This device has come into considerable prominence among school techniques within the last few years, and has been used extensively in the Buffalo school system. The silent reading form used in our experiments was an adaptation of the forms regularly used in the schools. It attempted to provide an introduction to the material which was to be covered in the museum visit by means of (1) a list of definitions of words which were used in the reading lesson proper and which were to be met during the museum visit; (2) a reading lesson which presented some interesting facts; and (3) a test based on the material read. Representative reading lessons and tests may be found in the Appendix, pages 75–77 and 89–91. For our experiments one silent reading lesson and test on the subject of *Birds* was made for the fifth grade pupils and another silent reading lesson and test on the subject of *Vertebrates* was made for the sixth grade pupils. These reading lessons and tests were administered by the school teachers during the regular school hours one week before the museum visit was to take place. About twenty minutes were allowed for the vocabulary drill and the reading lesson and about ten minutes were allowed for the test on the material read. In all cases the teachers were requested not to discuss with the pupils the material covered in the reading lesson between the time of the reading preparation and the time of the museum visit.

Although the test on the silent reading lesson has become a standard procedure in the schools, since there is every indication that the test has a teaching value all its own, our experimental conditions were arranged so that comparisons could be made between the effectiveness of (1) no preparation for the museum visit, (2) the preparation as provided by the silent reading lesson and vocabulary drill without the silent reading test, and (3) the preparation as provided by the silent reading lesson, vocabulary drill, *and* the silent reading test. Thus three large groups of fifth grade pupils and three large groups of sixth grade pupils from eighteen different schools were treated differently with respect to the preparation for the museum visit. The museum visit was handled in the same way for all pupils of a particular grade. In every other way the children were treated the same. That is, they came to the museum one week after the preparation in the schools (if preparation was given); they heard a 15-minute lecture with slides on the topic of the museum visit; they then made a tour of four museum galleries in company with docents, who gave them a running commentary on the objects seen in three galleries and provided them with game cards (See page 78) in the fourth gallery; and they were finally given a 20-item multiple-choice test in the museum at the end of the visit. The scores of the children in this multiple-choice test, which attempted to cover the fundamental facts presented during the visit, have been used to measure the effectiveness of the preparation in the schools.

The advisability of some preparation before the museum visit is clearly indicated by the average test scores presented in Table V. Since the silent reading lesson without the silent reading test increased

TABLE V

The Effect of Preparatory Study in the Schools on the Amount Known by the Children at the End of the Museum Visit

Type of Preparation Given in the Schools	Fifth Grade Children		Sixth Grade Children	
	N	Average Correct Test Answers	N	Average Correct Test Answers
A. No Preparation	473	14.66 ± .101	370	15.86 ± .074
B. Silent Reading Lesson Only	593	15.27 ± .067	502	15.79 ± .061
C. Silent Reading Lesson and the Silent Reading Test	447	15.45 ± .088	465	16.39 ± .067
Difference A–B/$P.E._{diff.A-B}$		5.04		0.73
Difference A–C/$P.E._{diff.A-C}$		5.90		5.30
Difference B–C/$P.E._{diff.B-C}$		1.62		6.59

N = Number of Children Tested.

the scores of the fifth grade children, but failed to increase the scores of the sixth grade children, it cannot be said that this part of the silent reading procedure is surely effective when it is used alone. However, the joint use of the silent reading lesson and the test as preparation produced test scores which were significantly higher than those obtained when no preparation had been given in the schools. This latter statement is justified by the fact that the differences for the fifth grade and sixth grade children are 5.90 and 5.30 times their respective Probable Errors, as given in the table. The failure of the sixth grade children to show an improvement in their test scores when they had the reading lesson without the test may perhaps have been due to chance sampling errors. If the results from the fifth grade and sixth grade children are considered together, it is probable that the order of effectiveness of the three conditions of this experiment was (1) the silent reading lesson plus the silent reading test, (2) the silent reading lesson without the test, and (3) no preparation.

Here, then, in the form of the silent reading lesson and test, so commonly used in the schools, is a device which may be used as an effective preparation for the museum visit, even though it is given an entire week before the visit. One may question whether the 30-minute reading period in the class-room could have had such a marked effect on the educational effectiveness of the museum visit without some rehearsal or review on the part of the children during the one-week interval. But it should be remembered that meaningful materials, such as those presented, suffer relatively slow forgetting.[1] The specific manner in which the preparation is effective is not, however, particularly important from the standpoint of museum education. The important point is that somehow the children get better acquainted with facts presented during the museum visit when they have a preliminary introduction to those facts before they enter the museum, and that this preparation is more effective when a test on the preparatory material is given.

EXPERIMENT II: THE EFFECTIVENESS OF VISUAL MATERIAL AS PREPARATION FOR THE MUSEUM VISIT

The success attained with the purely verbal reading as preparation for the museum visit encouraged an attempt to make the preparation even more effective by using pictures of objects which were to be seen in the museum. These were employed in conjunction with the silent reading lesson and test, and the lesson and test alone were used for the comparison condition. A large group of children was given as preparation the silent reading lesson and test, plus an opportunity to search out the answers to certain leading questions by examining pictures of museum objects which were distributed around the schoolroom. The questions used were presented as a game by means of game cards such as those used in the museum. (See Appendix, page 78.) The group of children which received only the verbal preparation, studied the silent reading lesson and test for 30 minutes; whereas, the experimental group studied the silent reading lesson and test for 30 minutes and then spent 15 minutes in searching out answers to the questions on the game card with the aid of the pictures.

The children used for the experiment were from the fifth and sixth grades and were to study *Birds* and *Vertebrates*, respectively, during their museum visits. The pictures of the birds and vertebrates were selected from prints belonging to the Audubon Society, the National Geographic Society, and Joseph H. Dodson, Inc., and were distinct in outline, properly colored, and showed the animals in their proper habitats. In all there were thirteen pictures of birds and sixteen pictures of various members of the vertebrate group.

In the museum, both groups of children were treated alike in that they had a 15-minute lecture with slides before the museum tour.

TABLE VI

The Effectiveness of Visual Materials in Addition to the Silent Reading Lesson and Test as Preparation for the Museum Visit

Type of Preparation Given in the Schools	Fifth Grade Children		Sixth Grade Children	
	N	Average Correct Test Answers	N	Average Correct Test Answers
Test in Museum:				
Silent Reading Lesson and Silent Reading Test	709	$11.58 \pm .142$	780	$13.51 \pm .155$
Silent Reading Lesson, Test, and Pictures with Game Cards	627	$12.19 \pm .142$	608	$15.86 \pm .175$
Difference/$P.E._{diff.}$		3.03		10.04
Test in School after 1 Week:				
Silent Reading Lesson and Silent Reading Test	684	$14.57 \pm .081$	754	$16.16 \pm .054$
Silent Reading Lesson, Test, and Pictures with Game Cards	604	$15.62 \pm .074$	580	$16.65 \pm .054$
Difference/$P.E._{diff.}$		9.55		6.45

N = Number of Children Tested.

They then toured the four galleries in the company with docents who lectured in two of the galleries and provided them with game cards in the other two galleries. One of the game cards used at this time was the same as the game card used a week earlier in the schools. A 20-item true-false test was given in the museum and a 20-item multiple-choice test was given in the schools one week after the visit.

As shown by the average number of correct responses made by the two groups of children on the immediate and delayed tests (Table VI), the use of the game card and the visual material in addition to the silent reading lesson and test was much more effective as preparation than the silent reading lesson and test alone. In the study of the effectiveness of the silent reading lesson and test as compared with no preparation, the silent reading lesson and test produced an increase of 5.4% and 3.3% in the immediate test scores of the fifth and sixth grade children. Since the use of the visual material and the silent reading lesson and test, instead of the silent reading lesson and test alone, increased the immediate test scores of the fifth and sixth grade children by 5.3% and 17.4%, respectively, there is some justification for believing that the game card and the visual material was as much more effective than the silent reading lesson and test as the silent reading lesson and test was more effective than no preparation at all.

It should, of course, be realized that this experiment is not analytical. It does not yield an estimate of the relative effectiveness of the visual material alone and of the silent reading lesson and test alone, nor does it say whether the silent reading lesson and test alone would have been as effective as the silent reading lesson and test plus the game card and visual material, if the time spent in the school-room preparation had been held constant. However, it seems reasonable to suppose that there would have been diminishing returns in the effectiveness of the silent reading lesson with increases in the time allowed for it, and that the superiority of the silent reading lesson plus the game card and visual material is attributable to the nature of the preparation as well as to the increase in the time spent in preparation.[2] This must, however, remain a conjecture until additional experiments have been performed.

EXPERIMENT III: THE EFFECTIVENESS OF THE SCHOOL PREPARATION AS A FUNCTION OF THE INTERVAL BETWEEN THE PREPARATION AND THE MUSEUM VISIT

In both Experiment I and Experiment II the length of time between the preparation in the schools and the museum visit was held constant at one week. This was, however, an arbitrary time interval which had been selected merely on the basis of convenience. Therefore, it seemed advisable to determine the time interval which would give maximal effectiveness to the preparation. Two possibilities regarding the optimal interval between the preparation and the museum visit were suggested by the data of experimental studies of memory. On the one hand, there is plentiful evidence that under most conditions, things which have been learned will be forgotten more and more as the period of learning becomes more and more remote in time.[3] If this general principle were applicable to our special problem, it would mean that the most effective interval between the preparation and the museum visit would be the shortest possible interval. On the other hand, there is equally sound evidence in the experimental psychology of memory to warrant the prediction that perhaps a two-day interval between the preparation and the museum visit would be more effective than a one-day or three-day interval. The interpolation of rest between periods of learning is generally conceded to be an economical procedure.[4] In addition, there is specific evidence for the belief that school children of the ages represented in our studies may remember more of a prose passage or poem two days after learning than they do one day after learning.[5] It is clear that the practice with respect to the interval between the preparation and the museum visit cannot be fixed by merely appealing to the psychology of memory. Instead, it is necessary to determine which of the two possible memory functions applies in these museum studies.

In our experiment, different groups of seventh grade and eighth grade children were given the silent reading lesson and test as preparation for the museum visit one day, two days, one week, and two weeks before the visit. The children in a fifth group from each of the grades were given no preparation for the visit. While in the museum, all five groups were treated in an identical manner. That is, the children were given a 15-minute lecture immediately after entering the museum; they were then conducted through four museum galleries by docents who were instructed to use a discussion technique for presenting the ideas and the characteristics of the museum objects; and they were given a 20-item multiple-choice test in the schools one week after the visit. The children in the seventh grade studied *Earth Science* and the children in the eighth grade studied the *Story of Man*. The silent reading lessons used in the seventh grade and the eighth grade were appropriate to the subjects of the museum visit and were the same for all those groups which had preparation in the schools.

As may be determined from an examination of the average test scores presented in Table VII, there is no evidence for the presence of the phenomenon of reminiscence under the conditions of this study.[6] On the contrary, there was a continuous decrease in the average test scores as the interval between the preparation for the visit and the visit proper increased. One day was the most effective interval and two weeks was the least effective interval. We cannot discover from this experiment the maximum time which may be permitted to elapse between the preparation and the museum visit without destroying altogether the effect of the preparation. With the eighth grade children, the silent reading lesson was probably effective as preparation even though it preceded the museum visit by as much as two weeks. The same conclusion does not follow from the averages of the seventh grade children, but it is highly probable that in this case the test scores of the seventh grade children who had no preparation before the visit were abnormally high because of chance or systematic errors in the equating of the experimental groups. This supposition finds some support from the fact that, if the data on the seventh grade children in this experiment are taken at their face value, the only

TABLE VII

The Effectiveness of Preparation for the Museum Visit as a Function of the Time Interval Between the Preparation and the Museum Visit

Time of Preparation in the Schools	Seventh Grade Children		Eighth Grade Children	
	N	Average Correct Test Answers	N	Average Correct Test Answers
Silent Reading Lesson 1 Day Before Visit..	334	15.33 ± .101	314	19.40 ± .101
Silent Reading Lesson 2 Days Before Visit..	332	14.99 ± .088	323	18.54 ± .094
Silent Reading Lesson 1 Week Before Visit.	338	14.70 ± .094	335	18.56 ± .094
Silent Reading Lesson 2 Weeks Before Visit.	379	14.59 ± .108	328	18.10 ± .094
No Preparation........................	309	14.96 ± .101	276	17.90 ± .115

N = Number of Children Tested.

effective interval for the use of preparatory material would be one day; whereas, we have found in our experiments that preparation one week before the museum visit was effective for the children of the fifth, sixth, and eighth grades. It seems improbable that the seventh grade children were affected in a manner unlike the children of these other higher and lower grades.

SUMMARY

It may be said that the data collected in the three experiments on the effect of preparation for the museum visit warrant the following generalizations: (1) A silent reading lesson and a test on the material read has a marked positive effect on the amount known by the children at the end of the museum visit, when given in the school not more than one week before the actual visit. (2) The test on the silent reading lesson is a valuable teaching device, and the effect of it is evidenced in the amount the children know at the end of the museum visit. (3) The use of pictorial materials and the game card technique in conjunction with the silent reading material increases the effectiveness of the preparation for the museum visit. (4) The preparation for the museum visit is more effective when it occurs one day before the museum visit than when it occurs two days, one week, or two weeks before the visit. There is evidence that the preparation has some effect even though it precedes the museum visit by as much as two weeks, but the conservative estimate is that an interval longer than one week reduces the effectiveness of the preparation to the vanishing point.

NOTES

[1] See J. A. McGeoch, Memory, *Psychol. Bulletin*, 1930, 27, 514–563, for a summary of recent experimental studies of the retention of meaningful materials, especially page 535.

[2] When the time spent in learning is plotted against the amount learned, the resulting curve is usually negatively accelerated, i.e., shows diminishing returns. See W. S. Hunter, Learning: IV. Experimental Studies of Learning, in *Handbook of General Experimental Psychology*, (Ed. by C. Murchison), 1934, Worcester, Massachusetts, pp. 497–570, especially pp. 501–502.

[3] See W. S. Hunter, *op. cit.*, pp. 539–543.

[4] Learning periods which are separated by appreciable intervals of time are usually more effective than massed learning periods. See W. S. Hunter, *op. cit.*, pp. 518–521.

[5] This phenomenon is known as reminiscence, and is frequently found in the retention of meaningful materials by subjects less than 12 years of age. See W. S. Hunter, *op. cit.*, pp. 543–546, and G. O. McGeoch, The Conditions of Reminiscence, *Amer. J. Psychol.*, 1935, pp. 47, 65–89, for general summaries of the conditions under which reminiscence is obtained.

[6] We have, in effect, measured the retention of the preparatory learning by the average scores of the children on the test. Reminiscence may have been present in individual cases, even though no evidence for the phenomenon was found in the averages. See on this point, G. O. McGeoch, The Age Factor in Reminiscence: A Comparative Study of Pre-school Children and College Students, *J. Genetic Psychol.*, 1935, 47, pp. 98–120.

Chapter IV

THE FUNCTION OF THE ILLUSTRATED LECTURE IN THE MUSEUM VISIT

At the time we began our investigations in the Buffalo Museum of Science, it was customary to take the children to a large auditorium and give them a 30-minute illustrated lecture on the subject of their visit. After this the children were taken into the halls of the museum and given lectures by the docents as they were grouped about the exhibits. Although this practice had certain practical advantages, such as the simplification of the task of quieting and adjusting the children to the museum immediately after they left the busses, it seemed legitimate to question whether the children received more benefit from the lecture than they would from spending the lecture time in the museum halls. Also, whether the formal lecture would serve better as a summary of the museum visit than as an introduction to the museum visit occurred as a valid subject for investigation. Since the answer to the question of the relative efficacy of the lecture as an introduction or as a summary was thought to be probably related to the educational method used by the docents during the tour of the museum halls, our investigations of this problem have been carried on in conjunction with the investigations of the relative effectiveness of the several educational methods used by the docents.

EXPERIMENT I: THE RELATIVE EFFECTIVENESS OF 30-MINUTE AND 15-MINUTE INTRODUCTORY FORMAL LECTURES

Our first investigation of the value of the formal lecture was concerned merely with the effect of shortening the lecture by half. Thus, in the first condition of the experiment, the children were given the customary 30-minute introductory lecture and then taken into the galleries for the visit which lasted approximately one and one-half hours. In the second condition, the length of the formal introductory lecture was decreased so that it consumed only 15 minutes, and the children were given an additional 15 minutes in the museum halls. The characteristics of one of the 15-minute lectures may be determined by examining the stenographic report in the Appendix, pages 78–81. The abbreviated form was achieved mainly through the elimination of a number of slides and some of the more detailed descriptions. In order to determine whether the discovered differences in the effectiveness of the two types of lectures were a function of the educational method used in the museum halls by the docents, the children who served under each of the two major conditions were divided into two sub-groups. One sub-group under each condition was given the usual lecture-type presentation by the docents in the museum halls and the other sub-group under each condition used game cards in each of the four museum halls.

All four of the groups of children that served in this experiment were treated in an identical manner with respect to all the other aspects of the museum visit. None of the children was given any preparation in the schools before the museum visit and all children were given a 20-item true-false test at the museum. The same test was repeated in the schools three months after the visit. The test also contained four free-response questions, but the scores on these questions will not be presented, since they were found not to be discriminative. Both fifth grade and sixth grade children were used in this study. The fifth grade children were given instruction on the subject of *Birds*, and the sixth grade children were given instruction on the subject of *Vertebrates*.

The results of this experiment confirmed the supposition that the entire 30-minute introductory lecture was not needed and that some of the time spent by the children in the lecture room could be more effectively spent in examining the displays in the halls of the museum. In Table VIII we have presented the average scores of the pupils of the fifth and sixth grades on the test administered immediately after the visit to the museum halls. The evidence is clearly in favor of a shortening of the formal introductory lecture. The pupils in both the fifth and sixth grades profited when 15 of the 30 minutes usually spent in the lecture room were spent in direct contact with the museum exhibits. Whether the additional time in the museum halls was spent in using game cards or in listening to lectures by the docents did not seem to be an important conditioning factor. The additional time in the museum halls was always beneficial, although there is some evidence that the additional time was more beneficial when the docents lectured in the halls than it was when the game cards were used in the halls. This follows from the fact that the average test scores increased 1.93 points and .71 points when lectures were given in the halls, and they increased only .58 points and .44 points when the game cards were used in the halls. The percentage increases were correspondingly different. As indicated by the ratios of the obtained differences to their Probable Errors, all four of the differences are not statistically significant, but the concurrence of all four differences with respect to direction lends weight to the inference that the shortening of the formal lecture time produced a significant increase in the amount of information possessed by the children at the end of the museum visit.

TABLE VIII

The Relative Effectiveness of 30-Minute Lectures and 15-Minute Lectures as Introductions to the Museum Visit: Tests Given Immediately after the Visit

Length of the Introductory Lecture	Lectures in the Halls		Game Cards in the Halls	
	N	Average Correct Test Answers	N	Average Correct Test Answers
Fifth Grade Children				
30-Minute Introductory Lecture	235	$9.35 \pm .182$	237	$9.18 \pm .202$
15-Minute Introductory Lecture	185	$11.28 \pm .216$	313	$9.76 \pm .175$
Difference/$P.E._{diff.}$		6.84		2.17
Sixth Grade Children				
30-Minute Introductory Lecture	194	$8.47 \pm .196$	214	$9.83 \pm .182$
15-Minute Introductory Lecture	197	$9.18 \pm .182$	303	$10.27 \pm .182$
Difference/$P.E._{diff.}$		2.66		1.71

N = Number of Children Tested.

In this investigation, the tests administered in the museum at the end of the visit were repeated in the schools three months after the visit in order to determine whether the alterations in the circumstances of the museum visit had permanent effects. The average scores of the children on this re-test are given in Table IX. The pupils in the fifth and sixth grades who were given an additional 15 minutes for the use of the game cards in the museum halls remained superior to those who had spent the additional 15 minutes in the lecture room. On the other hand, the data obtained from the fifth and sixth grade children who were given an additional 15 minutes of lecture by the docents in the museum halls are not consistent. The fifth grade children showed a permanent benefit from the additional time in the museum halls, but the sixth grade children who were given the additional lecture by the docents made a lower average score on the long-time retention test than those who were given the long introductory lecture. This reversal should not, however, be permitted to reduce confidence in the conclusion dictated by the other comparisons. The reversal in this case is wholly attributable to the performance of the sixth grade children of one of the three schools used for the 30-minute lecture condition. These children made a higher average score on the three-month re-test than they did on the test in the museum—a decidedly atypical performance. Since the children in the other eleven schools used in this experiment

TABLE IX

The Relative Effectiveness of 30-Minute Lectures and 15-Minute Lectures as Introductions to the Museum Visit: Tests Given 3 Months after the Museum Visit

Length of the Introductory Lecture	Lectures in the Halls		Game Cards in the Halls	
	N	Average Correct Test Answers	N	Average Correct Test Answers
Fifth Grade Children				
30-Minute Introductory Lecture........	213	7.51 ± .196	230	7.84 ± .196
15-Minute Introductory Lecture........	165	9.43 ± .229	290	8.24 ± .202
Difference/P.E.$_{diff.}$....................		6.38		1.42
Sixth Grade Children				
30-Minute Introductory Lecture........	120	5.19 ± .260*	173	6.33 ± .175
15-Minute Introductory Lecture........	192	5.83 ± .223	288	6.76 ± .209
Difference/P.E.$_{diff.}$....................		2.60		1.58

N = Number of Children Tested.

* This average excludes the records of one atypical school. See text, page 36. The uncorrected average is 6.96 ± .250.

showed the expected loss in retention from the first to the second test, it is legitimate to conclude that the children in the one school were either given additional training during the three-month period or were not handled in the standard fashion at the time of the re-test. When these scores are excluded, the average re-test performance of the sixth grade children who had the 30-minute lecture and the lectures in the museum halls is 5.19 ± .26. This is *lower* than the average score (5.83 ± .22) of the sixth grade children who were given the 15-minute lecture and the lectures in the museum halls.

The conclusion must be that some of the time usually spent by children in listening to an introductory lecture can be more effectively spent in direct contact with the museum exhibits. The benefits to be derived from the additional time in the museum halls accrue when either game cards or docent lectures are the teaching method used in the halls, and they are noticeable in the performance of the children on tests given either immediately after the museum visit or as long as three months after the visit.

EXPERIMENT II: THE EFFECT OF ELIMINATING THE FORMAL INTRODUCTORY LECTURE FROM THE VISITS OF THE FIFTH AND SIXTH GRADE CHILDREN

The proved superiority of the 15-minute introductory lecture over the 30-minute introductory lecture fosters a skeptical attitude toward the usefulness of any formal lecture in the course of the museum visit. It suggests that the time spent in the lecture room, however small in amount, may perhaps be spent more effectively in direct contact with the exhibits. An experiment modified this skepticism.

In the experiment, children of the fifth and sixth grades were given either a 15-minute introductory lecture or no formal lecture at all before they toured the museum halls in company with the docents. All the children were given a silent reading lesson and test one week before the museum visit. While in the museum, they were lectured to by the docents in three of the halls and were given game cards in the fourth hall. At the end of the visit, all the children were given a 20-item multiple-choice test on the material they had covered. The fifth grade children studied *Birds* and the sixth grade children studied *Vertebrates*. The groups of children subjected to each of the experimental conditions were large, since all the children from six schools were used in each condition.

The results of this experiment, as presented in Table X, seem to be of ambiguous import, but there is reason to believe that the apparent ambiguity is a function of the unequal importance of the introductory lecture in the training of fifth and sixth grade children. In the case of the fifth grade children, the 15-minute introductory lecture proved to be a much more effective teaching aid than the additional 15 minutes of informal lecturing before the exhibits. The difference between the average test scores of the two groups of children is not explainable as a chance difference ($\text{Difference}/\text{P.E.}_{\text{diff.}} = 12.26$.) On the other hand, the 15 additional minutes in the museum halls were just as effective as the 15-minute lecture in teaching the sixth grade children. The obtained difference is in favor of the complete elimination of the formal lecture, but it is not statistically significant (Difference/$P.E._{diff.}$ = 3.08), and the conservative interpretation is that neither condition was more advantageous than the other.

One interpretation of the apparently dissimilar educational effectiveness of the 15-minute lecture with fifth and sixth grade pupils is that the obtained averages are unreliable. It is true that some unrecognized factor may have been operating to confuse our experimental results, or that the difference in subject matter is the important factor. However, it would not be astute to discard these results without harboring, at least tentatively, the hypothesis that the need for some amount of formal and closely-knit lecturing is a function of the age level or educational level of the children. There is, in the results of

TABLE X

The Effectiveness of a 15-Minute Lecture as an Introduction to the Museum Visit When Docents Lecture in 3 Halls and Game Cards Are Used in 1 Hall

Comparison Conditions	Fifth Grade Children		Sixth Grade Children	
	N	Average Correct Test Answers	N	Average Correct Test Answers
No Introductory Lecture	499	14.04 ± .074	577	16.67 ± .061
15-Minute Introductory Lecture	447	15.45 ± .088	465	16.39 ± .067
Difference/$P.E._{diff.}$		12.26		3.08

N = Number of Children Tested.

this experiment, the suggestion that a formal introductory lecture which lasts for 15 minutes is a necessary part of an effective museum visit for children of the fifth grade, but that such a lecture may be dispensed with in the museum education of children of the sixth grade. If the suggestion is sound, the formal introductory lecture should not be a necessary feature of the museum visits of children from grades higher than the sixth. Experiment III was made in an effort to subject this implication to a test.

EXPERIMENT III: THE EFFECT OF ELIMINATING THE FORMAL INTRODUCTORY LECTURE IN THE VISITS OF SEVENTH AND EIGHTH GRADE CHILDREN

If the 15-minute introductory lecture is not an essential feature of the museum education of sixth grade children because the sixth grade children are sufficiently mature to learn by less stereotyped educational methods, the formal lecture should also be non-essential in the teaching of seventh and eighth grade children. That is, seventh and eighth grade children should make approximately the same scores on the museum test whether they received the 15-minute formal lecture or spent these 15 minutes in direct contact with the museum exhibits.

In Experiment III half of the pupils in the seventh and eighth grades were given lectures by the docents in all four of the museum halls visited, and the other half were taught by a discussion method. The latter method, which will be described in greater detail in Chapter V, had as its chief characteristic the use of leading questions by the docent

TABLE XI

The Effectiveness of a 15-Minute Introductory Lecture as a Function of the Method Used in Instructing the Children in the Museum Halls

Comparison Conditions	Lectures in the Halls		Discussion in the Halls	
	N	Average Correct Test Answers	N	Average Correct Test Answers
Seventh Grade Children				
No Introductory Lecture	491	12.68 ± .108	359	12.23 ± .101
15-Minute Introductory Lecture	399	12.58 ± .108	419	12.02 ± .088
Difference/P.E.$_{diff.}$		0.65		1.57
Eighth Grade Children				
No Introductory Lecture	424	14.70 ± .081	386	15.23 ± .094
15-Minute Introductory Lecture	417	15.12 ± .094	460	15.40 ± .088
Difference/P.E.$_{diff.}$		3.39		1.32

N = Number of Children Tested.

and the encouragement of the participation of the pupils in discussions of the exhibits and their significance. One-half of the children who were taught in the halls by each of these methods were given a 15-minute introductory lecture, and the other half were given no formal lecture whatsoever. All the children were given the silent reading lesson and test in the schools one week before the visit, and all were subjected to a 20-item multiple-choice test in the schools one week after the museum visit. No tests were given in the museum. The children of the seventh grade studied *Invertebrates*, and the children of the eighth grade studied *Earth Science*.

The average test scores of each of the four experimental groups in the seventh and eighth grades are presented in Table XI. Our expectation that neither the lecture condition nor the no-lecture condition would prove superior for these groups of children is clearly validated. None of the differences shown in Table XI are statistically significant, and only one difference has an appreciable magnitude. Moreover, two of the differences are in one direction, and the other two differences are in the opposite direction. When this experiment and Experiment II are considered together, the conclusion is that the formal introductory lecture is not a necessary feature of an effective museum visit for pupils of grades higher than the fifth, although it is an essential feature of an effective visit for fifth grade pupils. It is of some importance to note that the lecture proved non-essential for seventh and eighth grade pupils when either the lecture or discussion method was used in the museum halls.

EXPERIMENT IV: THE RELATIVE EFFECTIVENESS OF THE FORMAL LECTURE AS AN INTRODUCTION TO THE MUSEUM VISIT OR AS A SUMMARY OF THE VISIT

Our experiments have shown that a 15-minute introductory lecture is superior to a 30-minute introductory lecture, and that the formal introductory lecture is not at all necessary in the teaching of sixth, seventh, and eighth grade children. In view of the latter finding, it was suggested that the formal lecture might be a valuable part of the museum visit for children in grades above the fifth, if it were given at the end of the visit rather than at the beginning. As an introduction to the visit, the time spent in the lecture room is no more valuable than an equal amount of time spent in the museum halls, but those minutes in the lecture room might be exceptionally effective if they were used to summarize what had been learned in the museum halls. Accordingly, we made an experimental comparison of the effectiveness of the museum visit when it was introduced by a 15-minute formal lecture and the effectiveness of the same visit when it was concluded by the same 15-minute lecture.

Two different educational methods were used by the docents in the museum halls during this study. Half of the children who served under each of the lecture conditions were given the customary lecture-type talks during the tour of the museum, and the other half of the children were taught by the discussion method. All the children were given a silent reading lesson and test in the schools one week before the visit, and a 20-item multiple-choice test was administered in the schools one week after the visit. Children of the fifth and sixth grades were used as subjects because Experiment II had shown that these levels of educational maturity were critical in studies of the effectiveness of formal lectures. The topics studied by the children were *Birds* and *Vertebrates*, respectively.

The average scores of the various groups of pupils on the multiple-choice test are presented in Table XII. Clearly, no significant change in the average test scores of the children of the fifth and sixth grades occurred when the 15-minute lecture was shifted from the beginning to the end of the tour in which the docent lectured to the children. The differences in the case of both the fifth grade and sixth grade

TABLE XII

The Relative Effectiveness of a 15-Minute Lecture as an Introduction and as a Summary When the Docents Use the Lecture or Discussion Method in the Museum Halls

Position of the Lecture	Lectures in the Halls		Discussion in the Halls	
	N	Average Correct Test Answers	N	Average Correct Test Answers
Fifth Grade Children				
Lecture Preceding the Tour of Museum..	409	$14.46 \pm .094$	434	$13.99 \pm .101$
Lecture Following the Tour of Museum..	468	$14.67 \pm .088$	474	$14.36 \pm .088$
Difference/$P.E._{diff.}$....................		1.63		2.76
Sixth Grade Children				
Lecture Preceding the Tour of Museum..	444	$15.84 \pm .074$	472	$15.40 \pm .067$
Lecture Following the Tour of Museum..	459	$15.64 \pm .067$	516	$15.81 \pm .061$
Difference/$P.E._{diff}$....................		2.00		4.51

N = Number of Children Tested.

children are small, and are well within the limits of chance variation. On the other hand, the fifth and sixth grade children made somewhat higher scores on the test when discussions in the museum halls were followed by the formal lecture. The difference in the case of the sixth grade children is outside the limits of chance variation (Difference/$P.E._{diff.} = 4.51$), and the differences for the fifth and sixth grades are consistent in direction. Too much confidence cannot be placed in an interpretation based on such data, but they suggest that the formal lecture was more effective at the end than at the beginning of the visit whenever discussions replaced lectures during the tour of the museum. The suggestion gains credence through being rational. It seems entirely reasonable that the pupils needed a summarizing formal lecture after having "discussed" the exhibits, and that they did not need this lecture after having been lectured for 90 minutes about the exhibits.

SUMMARY

We have shown that children of the sixth, seventh, and eighth grades learn more when they spend the usual introductory lecture time in further direct contact with the museum exhibits. On the other hand, the fifth grade children need a short introductory formal lecture (15 minutes), although a long introductory lecture (30 minutes) is uneconomical. The formal lecture is equally effective for the fifth and sixth grade pupils whether it is placed at the beginning or the end of the museum visit, if the docents lecture to the children in the museum halls; but it is more effective at the end of the museum visit, if the discussion method is used in the halls. Under some conditions, therefore, the formal lecture may be an effective part of the education of children of the sixth (and presumably, the seventh and eighth) grade. The practical importance of this generalization for the teaching of sixth grade children may, however, be questioned in the light of the studies to be reported in Chapter V. The use of the discussion method in the museum halls cannot be recommended for the teaching of children of the sixth grade, and the advantages of the formal lecture as a follow-up of the discussion method become unimportant.

The results of the four experimental studies of the formal illustrated lecture are for the most part uncomplimentary to that educational device. It may seem surprising that another 15 minutes added to the usual 90 minutes spent among the museum exhibits is as effective as 15 minutes spent in listening to an organized, closely-knit lecture on the things to be learned. This is perhaps an indirect confirmation of the unusual effectiveness of direct contacts with the permanent exhibits offered by museums.

A skeptical attitude toward the usefulness of the type of formal lecture which we have used is to be encouraged, but it does not follow that *all* formal illustrated lectures are necessarily less useful than the direct contacts with the museum exhibits. We have not taken the nature of the formal lecture as an experimental variable, and until other types of the formal lecture have been found ineffective, our strictures must remain specific to the particular type of formal lecture investigated. This type is adequately illustrated by the verbatim transcriptions presented in the Appendix, pages 78–81 and 91–94.

Chapter V

METHODS OF INSTRUCTION USED IN PRESENTING THE MUSEUM EXHIBITS

As has already been indicated, the children spent the major portion of their time in the museum in contact with the museum exhibits. About eighty per cent of the two-hour period was spent in this way. In view of the great weight given to this aspect of the visit, it has been the subject of our most extensive investigations. In these studies an attempt has been made to determine which of several methods of instruction in the museum halls is the most effective, and whether the effectiveness of a particular method is conditioned by the educational maturity or intelligence of the children.

The customary procedure at the Buffalo Museum of Science at the time these investigations were begun was to have a docent take a group of children—usually one class of about 30 pupils—to each of four halls or sections of the museum in which materials relevant to the topic of the visit were shown. The order in which these sections were visited by the children necessarily varied from class to class, since four classes of a given grade were usually in the museum at one time. The teaching method used in each of the sections of the museum approximated an illustrated lecture with the museum exhibits as the illustrative material, and with the docent lecturing on each exhibit. Although the children were not discouraged from asking questions about the exhibits or the ideas presented, such activity on their part was not specifically encouraged. Concrete examples of these lectures may be found in the Appendix, pages 81–85 and 94–102.

The first variation from this customary technique was the use of game cards in place of the lectures by the docents. On entering a museum hall, each pupil was given a card on which 10 questions relating to the exhibits in the hall were printed. These questions were made extremely simple and straightforward in order that the children could discover the answers by merely looking at the exhibits or by reading some of the more general labels for the exhibits. (See the Appendix, pages 85–86, for examples.) By means of the preliminary instructions each child was given the task of discovering the answers to all the questions. Although this technique was designed to emphasize individual work, in the hope that by so doing each child would be more highly motivated toward the materials which were presented, the use of the game cards was accompanied by the close supervision of the docent in charge, and she gave the children such assistance as would facilitate the finding of the correct answers.

The function of these questions was not to test what the children could find out from looking at the exhibits, but rather to direct the attention of the children toward pertinent facts and relationships which were given during the docent's lecture in the usual teaching method. These cards were given out in each of the four halls visited by the children during a single tour, and the correct answers to the questions on the cards were told to the children by the docent at the end of the tour. It would perhaps have been better if we had been able to give the correct answers to the questions on each card at the end of the visit to the hall in question. This was not feasible. If the game card technique has any advantage over the usual lecture-type talk given by the docent, it must be because it emphasizes the more important facts to be presented, or because it requires that the children look directly at the exhibits at the time when a particular question regarding the exhibits is raised. It thus makes the maximum use of the educational potentialities of the visual material. Possible disadvantages of the method are that the children may not be coöperative, or that the answers to the questions which they discover for themselves may be incorrect. False ideas may in this way be ingrained and left uncorrected until, or even after, the docents have given the correct answers to the questions. Of these two disadvantages, the second is perhaps the most important to consider since it has been our experience that the game card technique sufficiently enlists the coöperation of children of all the grade levels and intelligence levels with which we have experimented.

A second variation from the customary method in the museum halls, which likewise differs to a considerable extent from the game card technique, is the technique which we have labelled "discussion." In the discussion method, the docent gave a leading question for discussion, such as, "From observing the Cro-Magnon Cave, do you know how anthropologists have learned about these people?" (See the Appendix, pages 86 and 102, for complete lists of the discussion questions used throughout the tours of fifth and eighth grade children.) The children were then expected to respond with their own ideas, after having given sufficient attention to the exhibit to understand the question. It was a common observation, when this technique was used, that the questions were frequently answered by only a few of the children; therefore, the docents made some attempt to bring the more reticent children into the discussion by asking them leading questions of a much more detailed nature. Whenever the children failed completely to discover through their coöperative efforts the correct answer to the question, or failed to single out the aspect of the exhibit which the museum authorities felt should be emphasized, the docent supplied the answer or emphasis. Obviously, this method differed from the game card method chiefly in that the children were given the benefit of one another's ideas, and in that the false observations or generalizations of the children were corrected immediately after they were made. In common with the game card technique, the discussion technique gave great emphasis to the general characteristics of the exhibits and the general ideas involved in them, rather than to details or nomenclature. The two methods were alike also in that they fostered an active study attitude.

One of the chief difficulties in experimenting with different methods of instruction, when more than one teacher is used, is that it is very difficult to get all the teachers to use the same "lecture" method and the same "discussion" method. In an attempt to standardize the procedure of all the docents used in these studies, the general pattern of all lectures was prescribed, and likewise the leading questions used in the discussion method were prescribed. In the case of the game card technique, this possible variation from teacher to teacher was minimized by printing all the questions on the game cards. A complete sample set of lectures, discussions, and game cards used during an entire tour is presented in the Appendix, pages 78–86.

EXPERIMENT I: THE RELATIVE EFFECTIVENESS OF LECTURES AND OF GAME CARDS WITH CHILDREN OF THE FIFTH AND SIXTH GRADES

The first experimental study of the methods used to teach the children in the museum halls was concerned with the effectiveness of the game card technique as compared with the traditional lecture method. The children selected for subjects in this study were from the fifth and sixth grades. It is of importance to note that this study is the same as the one reported as Experiment I in Chapter IV. The length of the formal introductory lecture was the other variable involved. Since the earlier analysis has indicated that the 15-minute introductory lecture was superior to the 30-minute lecture, whether the game cards or lectures were used in the museum halls, these sub-conditions of the docent lecture and game card conditions serve now merely as independent checks on the reliability of our conclusions regarding the teaching methods used in the museum halls.

The game cards were used in all four of the sections of the museum visited by the children, and, under the lecture condition, the docents lectured to the children in all four sections. These two conditions

TABLE XIII

The Relative Effectiveness of the Lecture Method and the Game Card Method in the Museum Halls When Used with Children of the Fifth Grade

Teaching Method Used in the Museum Halls	Test at End of Visit		Re-test After 3 Months	
	N	Average Correct Test Answers	N	Average Correct Test Answers
15-Minute Introductory Lecture:				
Lectures in Museum Halls	185	$11.28 \pm .216$	165	$9.43 \pm .229$
Game Cards in Museum Halls	313	$9.76 \pm .175$	290	$8.24 \pm .202$
Difference/$P.E._{diff.}$		5.47		3.90
30-Minute Introductory Lecture:				
Lectures in Museum Halls	235	$9.35 \pm .182$	213	$7.51 \pm .196$
Game Cards in Museum Halls	237	$9.18 \pm .202$	230	$7.84 \pm .196$
Difference/$P.E._{diff.}$		0.63		1.19

N = Number of Children Tested.

were, therefore, extreme instances of the use of the two teaching methods. In every respect other than the length of the introductory formal lecture and the educational method used in the museum halls, all the children were given the same treatment. None was given any preparation in the schools for the museum visit, and all received a 20-item true-false test at the end of the museum visit and again in the schools three months later. The children of the fifth grade studied *Birds*, and the children of the sixth grade studied *Vertebrates*.

In Table XIII are presented the averages of the test scores and re-test scores of the children of the fifth grade. In the test given immediately after the museum visit, these pupils answered more questions correctly when they had been lectured by the docents. When a 15-

minute lecture preceded the tour of the museum, the superiority of the lecture method was great ($\text{Difference}/\text{P.E.}_{\text{difference}} = 5.47$). The docents' lectures were again more effective than the game cards when the 30-minute formal lecture was used, but the difference between the average test scores was neither great, nor statistically significant. In the tests which were given three months after the museum visit, the children who had been given the lectures in the museum halls were still significantly superior in one case, but a statistically insignificant reversal of the general trend of the results occurred in the other case. We may interpret these data as indicating that the

TABLE XIV

The Relative Effectiveness of the Lecture Method and the Game Card Method in the Museum Halls When Used with Children of the Sixth Grade

Teaching Method Used in the Museum Halls	Test at End of Visit		Re-test After 3 Months	
	N	Average Correct Test Answers	N	Average Correct Test Answers
15-Minute Introductory Lecture:				
Lectures in Museum Halls	197	9.18 ± .182	192	5.83 ± .223
Game Cards in Museum Halls	303	10.27 ± .182	288	6.76 ± .209
Difference/P.E.$_{\text{diff.}}$		4.24		3.04
30-Minute Introductory Lecture:				
Lectures in Museum Halls	194	8.47 ± .196	120	5.19 ± .260*
Game Cards in Museum Halls	214	9.83 ± .182	173	6.33 ± .175
Difference/P.E.$_{\text{diff.}}$		5.09		3.64

N = Number of Children Tested.

* This average excludes the records of one atypical school. See text, page 36. The uncorrected average is 6.96 ± .250.

game card technique was certainly not superior to the lectures for the teaching of fifth grade children, and that the probability is high that the lecture method was actually superior to the game card method.

The differences between the average test scores of the sixth grade children (Table XIV) do not point to the same conclusion. The sixth grade children made higher scores on the immediate and delayed test when they used the game cards while in the museum halls. The game card technique was clearly superior when either the 15-minute or 30-minute lecture preceded the tour of the halls, and when the effectiveness of the methods was measured either by the tests in the museum or the re-tests in the schools three months after the visit. The differ ences between the average scores on the immediate test are statistically significant in both comparisons, and the differences between the average scores on the delayed test have a very small probability of being a result of chance alone.

We are again faced by data which suggest that the fifth and sixth grades flank a critical point in the relation between the educational level of the child and his reactions to different educational methods. It will be remembered that the fifth grade children were found to need some form of lecture as an introduction to the tour of the museum halls, and that the sixth (seventh, and eighth) grade children needed no such formal introduction. On the basis of the experiment just described, it may now be said that the most effective museum tour for fifth grade children is one in which they receive a 15-minute introductory lecture and then tour the halls of the museum in company with a docent who lectures to them; whereas, the most effective tour for sixth grade children is one in which they receive no introductory lecture, or at most a 15-minute introductory lecture, and then learn about the exhibits in the museum halls by discovering for themselves the answers to questions given on game cards.

EXPERIMENT II: THE RELATIVE EFFECTIVENESS OF LECTURES AND OF GAME CARDS WITH CHILDREN OF THE SEVENTH AND EIGHTH GRADES

Since our first experiment indicated that the game card was more effective than the lecture with children of the sixth grade, but that it was less effective than the lecture with children of the fifth grade, the second investigation was an attempt to determine whether the superiority of the game card held true for all the grades higher than the fifth. The seventh and eighth grade children who served in this experiment were given a silent reading lesson and test in the schools one week before the museum visit, and they heard a 15-minute introductory lecture at the museum. A 30-item true-false test was administered immediately following the tour of the museum halls, and a 20-item multiple-choice test was given in the schools one week after the museum visit. Both the seventh and eighth grades were given material relevant to the subject of *Invertebrates*. This circumstance is unique. In most of our experiments, the subject matter studied by children from the different school grades could not be held constant.

In the first condition of the experiment, children from six different schools were given lectures by the docents in each of the four halls of the museum which held exhibits relevant to the subject of *Invertebrates.* In the major comparison condition, children from another six schools were given game cards in each of the four halls. Finally, a third condition was introduced in order to determine whether a combination of the lecture and game card methods during a visit was more effective than the use of either method throughout the visit. Children from a third group of six schools were given lectures by the docents in two of the museum halls, and were given game cards in the other two halls.

TABLE XV

The Relative Effectiveness of the Lecture Method and Game Card Method in the Museum Halls When Used with Children of the Seventh and Eighth Grades

Teaching Method Used in the Museum Halls	Test at End of Visit		Test 1 Week after Visit	
	N	Average Correct Test Answers	N	Average Correct Test Answers
Seventh Grade Children:				
A. Lectures in 4 Halls................	432	13.19 ± .169	385	11.42 ± .094
B. Game Cards in 4 Halls............	388	13.55 ± .182	380	11.84 ± .096
Difference AB/P.E. $_{\text{diff. AB}}$.........		1.45		3.13
C. Lectures in 2 Halls and Game Cards in 2 Halls......................	384	13.78 ± .175	370	10.85 ± .094
Difference AC/P.E. $_{\text{diff. AC}}$.........		2.43		3.23
Difference BC/P.E. $_{\text{diff. BC}}$.........		0.91		0.07
Eighth Grade Children:				
A. Lectures in 4 Halls................	421	14.00 ± .175	401	11.70 ± .088
B. Game Cards in 4 Halls............	499	13.70 ± .16[illegible]	484	12.14 ± .081
Difference AB/P.E. $_{\text{diff. AB}}$.........		1.26		3.67
C. Lectures in 2 Halls and Game Cards in 2 Halls......................	582	14.25 ± .165	541	11.68 ± .080
Difference AC/P.E. $_{\text{diff. AC}}$.........		1.04		0.17
Difference BC/P.E. $_{\text{diff. BC}}$.........		2.38		4.04

N = Number of Children Tested.

Comparisons of the average scores of the children on the immediate and delayed tests suggest that there was no difference in the effectiveness of lectures and game cards for the teaching of seventh and eighth grade children (Table XV). None of the differences between the average scores made when lectures were used in all the halls and when game cards were used in all the halls are outside the range of chance variation. We can, at least, be practically certain that the game cards were neither more nor less effective than the lectures in the case of the eighth grade children. The consistency of the apparent superiority of the game cards for the seventh grade children, as measured by the immediate and delayed tests, is suggestive, but not definitive.

The answer to our question regarding the possibility of generalizing the superiority of the game card technique for all grades above the fifth is negative. When the results of Experiment I and Experiment II are considered together, it must be said that the game card is less effective than the lecture for children of the fifth grade, more effective than the lecture for children of the sixth grade, possibly more effective than the lecture for children of the seventh grade, and just as effective as the lecture for children of the eighth grade. The answer to the question why the effectiveness of the game card should wax and wane as the method is applied to children of successively higher levels of educational maturity cannot be given by our data. However, it may be suggested that the game card is ineffective with children of the fifth grade because it requires a considerable background of training in methods of study as well as a modicum of knowledge about the objects studied. The ineffectiveness of the game card method with children of the eighth grade is not so easily rationalized. It cannot be, as we shall soon demonstrate, that the quasi-discussion feature of the game card technique is unsuited to the older and more advanced children. On the contrary, the older students are benefited most by the straightforward discussion methods used in our later experiments. It may be that the real reason is extremely simple. For example, it may be that the game cards are ineffective with the older children because they are too infantile and thus offend the habitual attitudes of these children toward the question of how they should be taught when the teacher is in earnest.

Nothing definitive in the way of practical suggestions regarding the management of the tour of the museum halls can be gained from a study of the test-performance of the children when lectures were given in two halls and game cards were used in the other two halls. The highest average scores on the test in the museum were obtained by the groups of seventh and eighth grade children who served under this condition, but neither of the differences is statistically significant, and the re-test scores failed to confirm the differences shown in the scores on the immediate test. The problem of how much lecturing and how much of the game card technique is optimal must remain for future study. The results of this part of our experiment merely indicate that such a study may be highly profitable.

EXPERIMENT III: THE RELATIVE EFFECTIVENESS OF THE LECTURE METHOD AND THE DISCUSSION METHOD IN THE MUSEUM HALLS WITH CHILDREN OF THE FIFTH, SIXTH, SEVENTH, AND EIGHTH GRADES

Without questioning the value of continuing studies of the game card technique for teaching children in the museum halls, we have directed the major portion of our experimental efforts toward the determination of the relative merits of the customary lecture method and the so-called discussion method. The emphasis on the latter problem resulted from a number of considerations. Chief among these were the following: (1) The failure to obtain a simple relationship between the effectiveness of the game card and the educational level of the children suggested that an exact determination of the educational levels for which this method was most suited would entail an inordinate amount of experimentation. (2) A careful analysis of the game card method suggested that the method was too stereotyped unless supplemented by either the lecture or discussion methods. That is, the *pure* game card method, which left most of the process of the acquisition of knowledge to the ingenuity of the individual child, failed to make the best use of the guidance which the docent was equipped to give. If the game card were to be supplemented by discussions stimulated by the docents, then it seemed the wiser course to investigate the value of the discussion method, as compared with the lecture method, before experimenting with various forms of the game card method which involved large or small amounts of lecturing or discussion. In short, a knowledge of the relative effectiveness of the lecture method and discussion method in teaching the children about the museum exhibits appeared to be essential to an adequate understanding of the game card method. Once our attention was diverted to the discussion method, the game card method did not find further representation among our experimental conditions before the program of studies was discontinued.

The lecture and discussion methods which characterize the fundamental conditions in the experiments to be reported have already been described. A direct comparison of the lectures by the docents in the four museum halls during the tour of the fifth grade children in which *Birds* were studied, and of the corresponding discussion questions used by the docents in the same museum halls, may be made by referring to the Appendix, pages 81–85 and 86. A comparison of the content of the lectures and the discussion questions given to children of the eighth grade may also be made by referring to the Appendix, pages 94–102.

The first experimental comparison of the lecture and discussion methods made use of the children from the fifth, sixth, seventh, and eighth grades in order to discover at which educational level, if any, the discussion method became more or less effective than the lecture method. Every factor in the training of these children, with the exception of the teaching method used in the museum halls and the subject matter studied, was the same. Approximately half of the children from each grade who were assigned to us for experimental purposes were taught by the discussion method, and the other half were taught by the lecture method. All the children were given a silent reading lesson and test in the schools one week before the museum visit, and all were given a 15-minute introductory lecture in the museum. The effectiveness of the methods was measured by a 20-item multiple-choice test which was administered in the schools one week after the museum visit. The children of the fifth, sixth, seventh, and eighth grades studied the materials in the museum relevant to the subjects of *Birds*, *Vertebrates*, *Invertebrates*, and *Earth Science*, respectively. These differences in subject matter constitute the one known inconstant factor in the experiment.

A comparison of the average test scores presented in Table XVI reveals the discussion method as inferior to the lecture method for children of all grades except the eighth. Children in the fifth, sixth, and seventh grades made higher average scores on the test when the docents lectured to them during their tour of the museum. Only one of the obtained differences is more than four times the magnitude of its Probable Error, but the ratios of the other differences to their Probable Errors are sufficiently large to warrant the belief that the obtained differences represent true differences between the educational effectiveness of the methods. The change in the relative effectiveness of the lecture and discussion methods from the seventh grade to the eighth grade is so marked that it must be given credence. At least, we are justified in conjecturing that, under the conditions of this experiment, the lecture method is more effective than the discussion method for children of the lower levels of educational maturity represented, and that the discussion method is more effective than the lecture method for children of the upper levels of educational maturity represented. This general statement of the relationship has been verified by the later experiments.

The data which have been cited in Table XVI were actually obtained during two experiments which were conducted simultaneously. These experiments had additional conditions which involved variations in the formal illustrated lecture which was customarily given at the beginning of the museum visit. These other conditions may be cited at this time because they verify, in part, the conclusion just stated, and because they point to the possible importance of other factors in determining the effectiveness of the lecture and discussion methods.

TABLE XVI

The Relative Effectiveness of the Lecture Method and Discussion Method in the Museum Halls When Used with Children of the Fifth, Sixth, Seventh, and Eighth Grades

Grade	Subject	Lectures in the Halls		Discussion in the Halls		Difference / P.E.$_{diff.}$
		N	Average Correct Test Answers	N	Average Correct Test Answers	
5th	Birds	409	14.46 ± .094	434	13.99 ± .101	3.41
6th	Vertebrates	444	15.84 ± .101	472	15.40 ± .103	3.06
7th	Invertebrates	399	12.58 ± .108	419	12.02 ± .088	4.03
8th	Earth Science	417	15.12 ± .096	460	15.40 ± .087	2.15

N = Number of Children Tested.

TABLE XVII

The Relative Effectiveness of the Lecture Method and Discussion Method in the Museum Halls When Used with Children of the Fifth and Sixth Grades Before a Formal Summary Lecture

Grade	Subject	Lectures in the Halls		Discussion in the Halls		Difference / P.E.$_{diff.}$
		N	Average Correct Test Answers	N	Average Correct Test Answers	
5th	Birds	468	14.67 ± .088	472	14.36 ± .088	2.50
6th	Vertebrates	459	15.64 ± .067	516	15.81 ± .061	1.87

N = Number of Children Tested.

The first of these sub-experiments involved a change in the time of the 15-minute illustrated lecture in the visits of fifth and sixth grade children. The formal lecture was given at the end of the visit, rather than at the beginning of the visit. All other circumstances of the visit were the same as in Experiment I. As may be discovered by examining the averages in Table XVII, the lecture method was again superior to the discussion method with fifth grade children even though the formal lecture was given at the end of the visit, but in the case of the sixth grade children the discussion method was slightly superior to the lecture method under the same conditions. These differences are not large, and they are well within the range of chance variation. It may, therefore, be suggested that the difference between the effectiveness of the lecture and discussion methods may be greatly reduced, or even eliminated, by the use of an illustrated formal lecture as a summary of the museum visit. Although there is little statistical justification for the conjecture, we believe that the continued superiority of the lecture method for children of the fifth grade, under this condition which is favorable to the elimination of differences in the effectiveness of the two methods, is of considerable significance. This significance can best be stated when the remainder of the studies have been presented.

TABLE XVIII

The Relative Effectiveness of the Lecture Method and Discussion Method in the Museum Halls When Used with Seventh and Eighth Grade Children after Eliminating the Formal Introductory Lecture

Grade	Subject	Lectures in the Halls		Discussion in the Halls		Difference
		N	Average Correct Test Answers	N	Average Correct Test Answers	$\frac{}{P.E._{diff.}}$
7th	Invertebrates	491	12.68 ± .108	359	12.23 ± .101	3.04
8th	Earth Science	424	14.70 ± .081	386	15.23 ± .094	4.27

N = Number of Children Tested.

The second sub-experiment gave a comparison of the effectiveness of the lecture and discussion methods in the teaching of seventh and eighth grade children when the formal illustrated lecture had been completely eliminated. This change in the circumstances of the museum visit apparently produced no change in the relative effectiveness of the lecture and discussion methods. The average test scores presented in Table XVIII indicate the superiority of the discussion method for the children of the eighth grade. This difference in the effectiveness of the two methods for the two grades is the same as that previously found in Experiment I when a 15-minute illustrated lecture was given before the visit to the museum halls. This experiment is, therefore, valuable mainly as a substantiation of the suggested difference between the reactions of seventh and eighth grade children to the two teaching methods.

EXPERIMENT IV: THE RELATIVE EFFECTIVENESS OF THE LECTURE AND DISCUSSION METHODS IN THE TEACHING OF SEVENTH AND EIGHTH GRADE CHILDREN OF LOW, MEDIUM, AND HIGH INTELLIGENCE

The concluding experimental comparison of the lecture and discussion methods was the most extensive study conducted during the entire program of studies at the Buffalo Museum of Science, and, in our opinion, gives a basis for future studies in the field. All the seventh and eighth grade children who visited the museum during the year 1934–35 were used as subjects in this study. The most important feature of the experiment, from the standpoint of method, was the more adequate control of the factor of differences in the teaching abilities of the docents used to conduct the children through the museum. The importance of the experiment lies in the fact that it served as a specific check on the findings of the earlier experiment and also extended the scope of our generalizations regarding the relative effectiveness of the lecture and discussion methods.

The immediate objective of the experiment was to determine whether the children of the seventh and eighth grades were actually different in their reactions to the lecture and discussion methods. The importance to museums of a thoroughly substantiated statement regarding the educational level at which the discussion method becomes more effective or less effective than the customary lecture method is apparent. In the experiments just described, it seemed that the lecture method was the most effective for children of the seventh grade and that the discussion method was the most effective for children of the eighth grade. The new experiment did more than merely repeat the conditions of these earlier experiments under more adequately controlled conditions, because it permitted a re-determination of the effectiveness of the lecture and discussion methods for the seventh and eighth grade children when new subject matter was studied by each group. In Experiment III the seventh grade children studied *Invertebrates*, and the eighth grade children studied *Earth Science*. In the new experiment the seventh grade children studied *Earth Science*, and the eighth grade children studied the *Story of Man*. If the previously discovered effectiveness of the discussion method for the eighth grade children was a function of the subject of their visit, it should be discovered that the seventh grade children likewise benefited most from the discussion method when they studied the same subject. The introduction of the entirely new topic, *Story* *of Man*, for the visit of the eighth grade children permitted a check on whether the preference of the eighth grade children for the discussion method was specific to the visit in which *Earth Science* was the subject, or whether this other subject of similar complexity was also more effectively learned when the discussion method was used.

The scope of our studies of the effectiveness of the lecture and discussion methods was broadened in this new experiment by including the scholastic ability of the children among the experimental variables. Among the many classes which visited the museum during the year of this study many included only children of superior, average, or inferior ability, as measured by the Educational Quotient (E.Q.). Other classes were heterogeneous with respect to this variable, since the children in some of the schools were not grouped according to ability. The total number of children tested during this experiment was 11,287; only 31.2 per cent of this number were not in classes which were relatively homogeneous with respect to scholastic ability. Consequently, it was possible to obtain a sufficient number of children in each ability group to warrant the fractionation of our data on the entire groups which served under the lecture and discussion conditions. This fractionation is a valid analytic procedure, because the children of the various ability groups were never conducted through the museum halls together with children of a different ability group. However, it must be remembered that in many cases the segregation of the pupils according to ability was subject to error (See page 13).

All the children who served in this experiment were given a silent reading lesson and test in the schools one day before the museum visit. A 15-minute introductory lecture preceded each tour. The tests which served to measure the effectiveness of the instruction given in the museum consisted of 50 multiple-choice questions, and were administered in the museum at the end of the visit. Only 10 minutes were allowed for the answering of these questions. As will be noted, these tests were longer than those used previously, and should, therefore, have given a more adequate measure of the knowledge possessed by the children. Furthermore, the tests were more carefully constructed. In a preliminary study with the seventh and eighth grade children of one school, information tests of 100 items were administered, and the final 50-item test consisted of questions which were known to be both important and discriminative.

Special precautions were taken in order to make certain that obtained differences in the effectiveness of the lecture or discussion methods would not be determined to any significant extent by the teaching ability of the docents who were assigned to the classes which

TABLE XIX

The Proportions of the Total Groups Taught by Each of the Five Docents

Classification of Children	Docent A	Docent B	Docent C	Docent D	Docent E	Total N
	%	%	%	%	%	
Seventh Grade Children:						
Superior Children						
Lecture Method	18.9	25.1	19.5	20.1	16.4	586
Discussion Method	23.2	17.1	18.5	22.7	18.5	626
Average Children						
Lecture Method	18.9	21.1	21.4	17.2	21.4	772
Discussion Method	19.4	19.5	15.8	20.6	24.7	894
Inferior Children						
Lecture Method	21.0	15.4	21.8	22.2	19.6	586
Discussion Method	18.2	22.5	13.1	23.0	23.2	626
Unclassified Children						
Lecture Method	22.8	16.9	13.2	26.0	21.1	993
Discussion	19.8	21.5	20.4	20.0	18.3	1000
Total						
Lecture Method	20.6	19.3	18.3	21.8	20.0	2937
Discussion Method	20.1	20.2	17.3	21.3	21.1	3146
Eight Grade Children:						
Superior Children						
Lecture Method	19.5	19.8	23.5	15.5	21.7	621
Discussion Method	26.6	16.5	17.7	23.2	16.0	564
Average Children						
Lecture Method	19.8	18.8	22.7	18.2	20.5	687
Discussion Method	18.3	15.6	19.0	24.1	23.0	699
Inferior Children						
Lecture Method	24.6	13.8	26.2	14.0	21.4	520
Discussion Method	17.0	19.8	26.6	18.4	18.2	489
Unclassified Children						
Lecture Method	21.9	19.7	24.9	17.0	16.5	787
Discussion Method	17.2	15.5	24.1	20.1	23.1	837
Total						
Lecture Method	21.3	18.3	24.2	16.4	19.8	2615
Discussion Method	19.5	16.6	21.8	21.5	20.6	2589

N = Number of Children Tested.

served under the various experimental conditions. Only five docents were used to teach the children, and every docent taught approximately the same number of superior, average, inferior, and unclassified children by the lecture method and by the discussion method. The percentages of the children in each group taught by each of the five docents are given in Table XIX. The deviations from perfect constancy in the number of children taught by each docent were unavoidable. The children were assigned to the docents by classes, and the classes varied greatly in size.

The averages of the test scores of each of the groups of children who served under the various conditions of this experiment are shown in Table XX. The answers to the questions which were stated as the immediate objectives of the experiment are unequivocal. It is clear

TABLE XX

The Relative Effectiveness of the Lecture and Discussion Methods When Used in the Museum Halls with Seventh and Eighth Grade Children of Various Levels of Intelligence

Intelligence Level	Lectures in the Halls		Discussion in the Halls		Difference
	N	Average Correct Test Answers	N	Average Correct Test Answers	$\frac{\text{Difference}}{\text{P.E.}_{\text{diff.}}}$
7th Grade Children:					
Superior	586	30.28 ± .290	626	32.60 ± .202	6.80
Average	772	27.06 ± .182	894	29.27 ± .155	9.25
Inferior	586	24.76 ± .189	626	26.18 ± .182	5.42
Mixed Group	993	28.60 ± .155	1000	27.93 ± .162	2.99
Total	2937	27.88 ± .095	3146	28.87 ± .088	7.67
8th Grade Children:					
Superior	621	36.74 ± .155	564	[illegible] ± .162	1.12
Average	687	33.75 ± .169	699	[illegible] ± .162	2.74
Inferior	520	31.72 ± .182	489	31.98 ± .189	0.99
Mixed Group	787	34.00 ± .169	837	35.03 ± .155	4.50
Total	2615	34.06 ± .088	2589	34.71 ± .081	5.42

N = Number of Children Tested.

that, on the whole, the discussion method was superior to the lecture method for the instruction of both seventh and eighth grade children. When the ability groupings are disregarded, the seventh and eighth grade children who were encouraged to discuss the exhibits made scores on the test which were significantly higher than the scores made by comparable groups of children who were given lectures by the docents. Furthermore, the superiority of the discussion method is attested by nine of the ten comparisons of the averages which were obtained by dividing the large groups into sub-groups on the basis of the scholastic ability of the children.

The major implication of these findings is that seventh grade children may profit from the use of the discussion method in the museum halls, if the subject matter is suited to the method. It will be remembered that in Experiment III the children of the seventh grade learned more about *Invertebrates* when the lecture method was used, and that the children of the eighth grade learned more about *Earth Science* when the discussion method was used. Since the discussion method has proved superior to the lecture method for both the seventh and eighth grades when they studied *Earth Science*, it follows that our earlier conclusion to the effect that the seventh and eighth grades flanked a critical point in the relationship between educational level and the relative effectiveness of the discussion method was in error. All that can be said is that the relative effectiveness of the lecture and discussion methods for the teaching of children of the seventh grade depends on the type of material presented. As for the children of the eighth grade, we have found two bodies of subject matter which were most effectively presented by the discussion method, and it is a reasonable conjecture that children of this level of educational maturity assimilate knowledge most readily when they are encouraged to give verbal form to their own ideas and observations. But in applying this suggestion, it should be remembered that the superiority of the discussion method may not be great. Only one of the four differences obtained with the sub-groups of the eighth grade children in this experiment was statistically significant, although the differences were consistent in direction.

Two of the subsidiary variables which were thought to be significant at the time this investigation was planned proved to be unimportant as determinants of the relative effectiveness of the lecture and discussion methods. It was thought that the scholastic ability of the children in a particular school grade would be of some importance in this connection. Although the average test scores of the superior, average, and inferior groups of children substantiate the school room classifications, the discussion method was consistently the better teaching method. Furthermore, there is no evidence that the extent of the superiority of the discussion method varied with the scholastic ability of these children.

A common objection of the docents to the use of the discussion method had been that some of the children in each class dominated the discussions, and other less forward children rarely participated.

It was thought that a grouping of the children which excluded extreme individual differences in ability might reduce such inequalities, and thereby increase the relative effectiveness of the discussion method. If so, the children in the homogeneous ability groups in our experiment should have benefited relatively more from the use of the discussion method than the children in the unclassified or "mixed" groups. The data on this point are equivocal. Among the seventh grade children, those who toured the museum in groups heterogeneous with respect to ability were the only ones to find the lecture method superior to the discussion method, and the suggestion appears to be validated. On the other hand, the heterogeneous groups of eighth grade children seem to have profited more than any of the others from the use of the discussion method. It is almost inconceivable that the difference in the grades to which the children belonged could have affected the consequences of the homogeneity-heterogeneity factor to this extent. Consequently, the question must be left without an answer.

SUMMARY

The results of the experiments reported in this chapter are not susceptible to such concise summarization as has been given the experiments reported in the previous chapters. This circumstance is undoubtedly a function of the nature of the educational problem with which the experiments have been concerned. We have attempted to discover fundamental differences in the effectiveness of three ways of presenting museum materials to children of the fifth, sixth, seventh, and eighth grades when the topics studied varied from grade to grade. That is, we have attempted to determine the relation between the educational level of the child and the relative effectiveness of the three teaching methods when the subject matter presented to the children in the different grades varied concomitantly with the educational level. This appears to be a serious disregard of the elementals of sound experimental method, and so it is. However, at the inception of these studies we made a critical inquiry regarding the relative usefulness of knowing (a) which one of the three methods of instruction was most effective at each of the educational levels when all the children studied, let us say, *Invertebrates*; and (b) which one of the three methods was most effective for teaching children of a particular grade the subject matter which the museum and school authorities felt to be most suited to their needs, interests, and level of maturity. The decision was in favor of the second alternative and our experimental results must be evaluated accordingly.

The game card technique has been found to be definitely less effective than the customary lecture method for teaching fifth grade children about *Birds*; it was more effective than the lecture method for teaching the sixth grade children about *Vertebrates*; it was perhaps slightly more effective than the lecture method for teaching the subject of *Invertebrates* to seventh grade children; and it was neither more nor less effective than the lecture method for teaching *Earth Science* to eighth grade children. In view of the fallibility of our determinations, it is wise to withhold general conclusions regarding the usefulness of the game card technique until further experiments have been performed. However, it should be emphasized that the game cards were clearly more effective than the usual lectures by the docents in the teaching of the children of only one of the four grades. In view of the variation in the subject matter from grade to grade, this also means that the game card technique was clearly superior in the teaching of only one of four different topics. The waxing and waning of the relative effectiveness of the game card technique as it was used with the fifth, sixth, seventh, and eighth grades may be valid, but this finding cannot be applied with confidence until more analytic studies of the game card technique have been performed.

The relative effectiveness of the discussion method in the presentation of the museum exhibits, as compared with the effectiveness of the lecture method, has also proved to be a function of either the educational level of the children or the subject matter studied. The fifth grade children again learned more about *Birds* when the docents lectured in the museum halls. The children of the sixth grade learned more about *Vertebrates* when the lecture method was used in presenting the museum exhibits and the 15-minute formal illustrated lecture was given to them at the beginning of the visit; but they learned equally well under the lecture and discussion conditions when the formal illustrated lecture was given at the end of the visit. With the children of the seventh grade, the lecture method was superior for the teaching of facts about *Invertebrates*, but the discussion method was superior for the teaching of *Earth Science*. Finally, the children of the eighth grade learned more about both *Earth Science* and the *Story of Man* when the discussion method was used by the docents.

A comprehensive view of these experimental results seems to warrant a few general statements. In the first place, it should be noted that the children of the fifth grade always learned more when the docents lectured to them in the museum halls than they did when either game cards or the discussion method were used. Even the shift of the 15-minute formal illustrated lecture from the beginning of the visit to the end of the visit did not overcome this difference in the effectiveness of the methods. In the second place, there is an accumulation of evidence in favor of the belief that the relative effectiveness of the discussion method, as compared with the lecture method, increases as the level of maturity of the children increases. As previously noted, the fifth grade children always profited most from the use of the lecture method; the sixth grade children profited most from the lecture method unless a formal summarizing lecture was given at the end of the museum visit; the seventh grade children profited most from the lecture or discussion methods according to the subject matter studied, but the discussion method was unequivocally superior with certain subject matter; and the children of the eighth grade profited most from the use of the discussion method when they were learning either one of two different subjects. There is, therefore, some warrant for the conjecture that the effectiveness of the discussion method increases as the educational age of the children increases.

The negative conclusion of our study of the effectiveness of the lecture and discussion methods with the children of high, average, and low scholastic ability within the seventh and eighth grades indicates that the relationship between educational maturity and the relative effectiveness of the two teaching methods is either more a function of educational age than of educational ability, as measured by the E.Q., or that the differences in ability represented by our groups were not sufficiently marked to make possible the measurement of differences in the effectiveness of the teaching methods.

CHAPTER VI

THE TEACHING ABILITY OF THE MUSEUM DOCENT

One of the major determinants of the degree of success of every educational program is the ability of the individual to whom is entrusted the task of teaching. In the educational program of a museum, the docent who conducts the school children through the museum halls is an important factor in the complex of factors which determine the extent to which the children actually benefit from the experience. This much can be said without specific reference to the data collected in our experiments. However, the full extent of the importance of this factor has not, we believe, been realized. The data we have to report give a greatly needed emphasis to the generalization, and, in addition, they indicate the extent to which the teaching ability of the museum docent may be considered as free from conditioning factors such as the subject matter taught, the method of teaching used, etc. The following questions have received particular attention: Is the ability of the docent more important than the other factors in the program of museum education which have been subjected to experimental evaluation, even though the museum authorities have selected the docents with the greatest of care? Do the methods used by museums for selecting their docents permit relatively incompetent individuals, i.e., individuals who are consistently less effective in their teaching than others, to obtain and continue in such positions? Is there a marked difference in the relative competence of a docent in the teaching of different subjects? Is there a marked difference in the relative competence of a docent when she is teaching by the lecture method and when she is teaching by the discussion method?

None of our studies in the Buffalo Museum of Science was specifically focused on the problem of determining the differences in the teaching abilities of the docents provided by the museum. Instead, these evaluations of teaching ability have been by-products of the investigations which have been reported in the preceding chapters. Consequently, the present analysis does not provide an aptitude test for the selection of new docents. But the facts revealed may serve as a useful foundation for the later development of such a device for personnel selection. In short, no attempt has been made to correlate the measured teaching ability of the museum docents with their individual traits, such as intelligence, amount of training, amount of experience, etc. All that was known about the docents was that they were all women, and that they were considered by the museum authorities to have been as adequately trained for their teaching positions as the average elementary school teacher.

The comparisons of the teaching effectiveness of the museum docents have been based on the test scores of the children taught by them in the museum halls. This method of measurement of teaching ability obviously requires that the groups of children who were taught by the docents be equivalent in their receptiveness to the museum material and equivalent in scholastic ability or achievement. In all the earlier studies in the Buffalo Museum of Science the number of children who served under any one condition of an experiment rarely exceeded six hundred. When even as many as six hundred children were divided into five or more groups according to the docent who directed them through the museum halls, the number of children in each group was too small to give a reliable indication of the teaching ability of the docent. Furthermore, the children included in each group were not equalized with respect to the important factor of scholastic ability or achievement, and the obtained differences between the average test scores of groups taught by different docents were frequently explainable as the result of differences in the learning ability of the children. Consequently, our entire analysis of the docents' ability as a factor in the effectiveness of the museum visit rests on the data collected during the extensive study of the relative effectiveness of the lecture and discussion methods for the teaching of seventh and eighth grade children (Experiment IV, Chapter V). Nearly twelve thousand children in the seventh and eighth grades were taught by five docents in this experiment, and, since there were only two basic experimental conditions, the number of children included in the groups taught by the several docents was sufficiently large to minimize chance inequalities of the groups. Furthermore, most of the classes were grouped as superior, average, or inferior in scholastic ability, and each of the five docents were given classes from each of those levels. The average test scores obtained were, of course, not completely free from the influence of factors other than the docent's teaching ability, so that even in this study the measures of the docent's ability must be considered as relatively crude. They have, however, proved sufficiently discriminative to warrant certain specific conclusions.

TABLE XXI

Average Test Scores of the Children Taught by the Five Docents Used in the Experimental Study of the Effectiveness of the Lecture and Discussion Methods with Seventh and Eighth Grade Children

Classification of Groups Taught	Docent A		Docent B		Docent C		Docent D		Docent E	
	N	Average	N	Average	N	Average	N	Average	N	Average
Seventh Grade,										
Lecture Method:										
Superior Ability.....	111	34.68	147	29.20	114	32.09	118	26.73	96	32.90
Average Ability.....	146	27.15	163	25.97	165	28.05	133	26.92	165	27.21
Inferior Ability......	123	24.33	90	24.06	128	24.63	130	26.51	115	23.67
Unclassified.........	226	28.03	168	27.00	131	28.08	258	29.84	210	30.50
Average of Averages.		*28.55*		*26.56*		*28.21*		*27.50*		*28.57*
Seventh Grade,										
Discussion Method:										
Superior Ability.....	145	31.28	107	32.23	116	33.82	142	32.91	116	33.43
Average Ability.....	174	30.72	174	26.79	141	32.07	184	30.07	221	27.65
Inferior Ability......	114	26.70	141	25.73	82	26.01	144	26.90	145	25.61
Unclassified.........	198	25.80	215	27.94	204	29.40	200	29.46	183	26.31
Average of Averages.		*28.63*		*28.17*		*30.33*		*29.84*		*28.25*
Eighth Grade,										
Lecture Method:										
Superior Ability.....	121	34.51	123	38.02	146	36.15	96	37.56	135	37.61
Average Ability.....	136	33.32	129	33.72	156	33.47	125	34.39	141	33.99
Inferior Ability......	128	31.09	72	30.07	136	32.12	73	31.14	111	31.71
Unclassified.........	172	31.62	155	33.31	196	35.40	134	34.04	130	35.85
Average of Averages.		*32.64*		*33.78*		*34.29*		*34.28*		*34.79*
Eighth Grade,										
Discussion Method:										
Superior Ability.....	150	36.05	93	36.73	100	36.85	131	38.40	90	36.79
Average Ability......	128	33.84	109	32.96	133	32.16	168	35.93	161	36.02
Inferior Ability......	83	33.73	97	29.79	136	30.42	90	33.83	89	33.21
Unclassified.........	144	33.81	130	35.25	202	34.50	168	35.73	193	35.78
Average of Averages.		*34.36*		*33.68*		*33.48*		*35.97*		*35.45*

N = Number of Children Tested.

The data which have served as the basis for our analysis have been presented in Table XXI. These are the average test scores of each of the groups of children taught by each of the five docents. In an attempt to get some *absolute* measure of the effect of the docent's teaching ability on the test scores of the children, we have *averaged the average test scores* of the superior, average, inferior, and unclassified groups taught by each docent.[1] These are shown by the italicized figures in the fifth line in each of the major divisions of the table. It is apparent that marked differences in the test scores of the children may be attributed to the teaching ability or inability of the museum docents. For example, the averages for the children of the seventh grade who were taught by Docent *B* by the lecture and discussion methods were 26.56 and 28.17, respectively; whereas, the average for the children taught by Docent *E* by the lecture method was 28.57, and the average for the children taught by Docent *C* by the discussion method was 30.33. Correspondingly large average differences were obtained with the children of the eighth grade. The true significance of these differences of about two points becomes apparent when they are compared with the average differences in test scores produced by the use of the lecture and discussion methods in this study (Table XX, page 58). The difference between the average test scores of the seventh grade children under the lecture and discussion conditions of this experiment was 0.99, and the corresponding difference in the case of the eighth grade children was 0.65. The answer to the first of our questions regarding the teaching ability of the docents is, therefore, unequivocal. In a small group of docents who have been selected with great care, the differences in the effectiveness of their teaching may overshadow the differences in the effectiveness of the museum visit which may be attributed to the other factors in the situation, such as the method of instruction used, and probably the use of preparation in the schools, the use of illustrated formal lectures, etc.

The answers to the other questions which have been listed are best obtained by discarding measures of the absolute effectiveness of the docents, and substituting measures of their relative effectiveness. The simplest, and most legitimate, method for achieving a rough estimate of the abilities of the docents when they were teaching seventh or eighth grade children, or when they were using the lecture or discussion methods, appeared to be the average rank of each docent among the five docents. Thus, in order to determine the relative effectiveness of Docent *A* in the instruction of seventh grade children, her rank among the five docents in the teaching of the superior, average, inferior, and unclassified groups by both the lecture and discussion methods was obtained separately for each group, and then these eight ranks were averaged.

Comparisons of the results obtained by this ranking procedure are decisive in their implications, and the consistency with which certain docents ranked high and low substantiates our previous claim that fundamental differences in ability were present. In Table XXII are

TABLE XXII

The Distribution of Ranks and the Average Ranks of Each Docent in the Teaching of Seventh and Eighth Grade Children by Either the Lecture or Discussion Methods

Rank	Frequency Docent A	Frequency Docent B	Frequency Docent C	Frequency Docent D	Frequency Docent E
Seventh Grade Children:					
First	1		4	3	1
Second	3		1	1	3
Third	2	1	3	2	
Fourth		4		1	3
Fifth	2	3		1	1
Average	2.88	4.25	1.88	2.50	3.00
Eighth Grade Children:					
First	1	1	1	4	3
Second		1	2	2	3
Third	2	2		2	2
Fourth	1	2	4		
Fifth	4	2	1		
Average	3.88	3.38	3.25	1.75	1.88
Seventh and Eighth Grade Children:					
First	2	1	5	7	4
Second	3	1	3	3	6
Third	4	3	3	4	2
Fourth	1	6	4	1	3
Fifth	6	5	1	1	1
Average	3.44	3.81	2.56	2.13	2.44

presented frequency distributions of the ranks obtained by each docent in the teaching of seventh and eighth grade children by either the lecture or discussion method. The average ranks are also indicated. The frequency distributions indicate the frequency with which each docent was first, second, third, fourth, and fifth in rank.

An examination of the distributions of the ranks obtained by each of the five docents for the teaching of both seventh and eighth grade children reveals Docent *D* as definitely superior to all the others and Docent *B* as definitely inferior to all the others. Of the sixteen groups taught by Docent *D*, seven made the highest average test score. Of the sixteen groups taught by Docent *B*, only one made the highest average test score, and only one made the second highest score, while six made the second lowest score, and five made the lowest score. Moreover, the teaching of these two docents appears to have been consistently superior and inferior when they were teaching either *Earth Science* to the seventh grade children or the *Story of Man* to the eighth grade children. But this evidence that the docents could be characterized as superior or inferior without regard to the subject

TABLE XXIII

Average Ranks of Each Docent in the Teaching of Seventh and Eighth Grade Children by the Lecture Method and by the Discussion Method

Method of Instruction	Av. Rank Docent A	Av. Rank Docent B	Av. Rank Docent C	Av. Rank Docent D	Av. Rank Docent E
Seventh Grade Children:					
Lecture	2.25	4.50	2.25	3.00	2.50
Discussion	3.50	4.00	1.50	2.00	3.50
Eighth Grade Children:					
Lecture	4.25	3.25	2.75	2.25	2.00
Discussion	3.25	3.50	3.75	1.25	1.75
Seventh and Eighth Grade Children:					
Lecture	3.25	3.88	2.50	2.63	2.25
Discussion	3.38	3.75	2.63	1.88	2.63

taught is not substantiated by the performance of the other three docents. Docent *C* had first rank in the group when she was teaching the seventh grade children, but was definitely inferior to Docents *D* and *E* when she taught the eighth grade children. Conversely, Docent *D* showed only mediocre ability in the teaching of the seventh grade children, but was extremely successful in teaching the eighth grade children. Consequently, it may be concluded that the effectiveness of a docent is frequently, although not always, conditioned by the subject matter which is taught, even though all the topics fall well within the scope of a museum of science.

Although the topic of the museum visit is an important determinant of the teaching effectiveness of any one museum docent, the same is not true regarding the method of instruction used. In general, the docent who is very effective in the teaching of *Earth Science* by the lecture method, is also effective in the teaching of *Earth Science* by the discussion method which was used in these studies. This is clearly shown by the average ranks of the five docents in the teaching of seventh and eighth grade children by the lecture and discussion methods (Table XXIII). The correlations between the average ranks of the docents when they were using the lecture method and their average ranks when they were using the discussion method is not perfect, but it must be considered extraordinarily high in view of the small number of determinations which were averaged in order to obtain each docent's average rank. Apparently, it is much more important that a docent be capable of teaching a particular subject than it is that she be capable of teaching in a particular manner.

SUMMARY

Our data demonstrate beyond peradventure the extreme importance of the ability of the docent in the determination of the effectiveness of a museum visit for the education of school children. It is a reasonable conjecture that the docent's ability is not only the most important factor, but also that the difference between the amounts children will learn from a good docent and a poor docent is greater than the difference produced by the manipulation of many other circumstances of the museum visit. This conclusion is not particularly startling unless one realizes that the five docents used in this investigation were highly selected. The five docents were selected by the Education Department of the Buffalo Museum with extraordinary care, and after careful scrutiny of their academic records and past experience in teaching. Furthermore, the five docents used in our experiment were the survivors of a larger group, many of the others having been discharged because their inferior abilities became apparent to the supervisors. The differences we found were, therefore, differences in the abilities of experienced and permanent docents.

The continuation of the services of the one docent who was found to be definitely less effective than the others cannot be attributed to the Education Department of the Buffalo Museum of Science, but rather to the inadequacy of the previously available methods for judging the relative effectiveness of this docent. Our measurements of the effectiveness of the docent in terms of the test scores of children taught by her have *prima facie* validity when the groups of children used in such a study have been equated in learning ability. Such a method of measurement can be simplified and made more economical. With such measurements as criteria of the teaching effectiveness of an individual, it should be feasible to develop a battery of tests which will predict the effectiveness of a prospective docent, and thus save museums the great losses in educational effectiveness which result from the probation method now in force.

But such direct measurements have a far more important use as a check on the effectiveness of a docent's teaching of specific subjects. We have found that two of the five docents at the Buffalo Museum of Science were superior teachers of one subject but inferior teachers of another subject, and that the superiority or inferiority of a docent was not a function of the method of instruction used. These facts point to the conclusion that the amount of familiarity with the subject matter may often be a prime determinant of success in teaching the children. This implies a need for more intensive training of the docents in the subjects which they are called upon to teach, in order that every docent may achieve the maximum of teaching effectiveness in every subject which the museum attempts to present to the school children. Such measurements as we have used could serve as indicators of the need for further specific training of docents who were known to be capable of successful teaching.

If museum authorities fail to avail themselves of the opportunity to obtain objective measurements of the performances of their docents, their programs of coöperation with the schools may fall short of maximal success because of inadequacies of the teaching personnel, even though many of the other circumstances of the museum visit are those which we have found to be maximally effective. Extraordinary care in the selection and supervision of docents does not seem to be sufficient to assure a maximally effective personnel.

NOTES

[1] The average of the averages for the superior, average, inferior, and unclassified groups have been used in order that the *relative* number of superior children, average children, inferior children, and unclassified children taught by each docent would not determine the size of the grand averages. In effect, we have assumed that each docent taught the same number of superior, average, inferior, and unclassified children, and that every docent taught the same number of children of each group.

Chapter VII

THE EFFECTIVE MUSEUM VISIT FOR SCHOOL CHILDREN

Scheduled museum visits by elementary school children have become during the past fifteen years an accepted phase of the educational programs of museums. In these years great progress has been made toward perfecting this coöperative venture of schools and museums in certain communities, of which the City of Buffalo is representative. For the most part, this progress has been in the direction of perfecting the techniques of the museums for accommodating the children, and in extending the service so as to include children of many different school grades and a greater representation of children from each grade. Accordingly, there has been a great increase in the number of different children who benefit from the service. The present-day peak of this progress is adequately represented by the program of coöperative work of the Buffalo Museum of Science, which provides for the instruction of every fifth, sixth, seventh, and eighth grade child on one day during each year. This once-a-year-per-child characteristic of the program is typical of school-museum coöperative educational work, and it means that the museum visit remains as an infrequent, and relatively unique, opportunity for educational service to the children.

This uniqueness of the museum visit is the justification for serious and persistent attempts to make it pay the maximal educational dividends. Museums should not be content to accept any aspect of the visit as effective, until it has been shown that no more effective condition or method of instruction exists. Furthermore, the problem of perfecting the museum visit, through experimentation with the many aspects of it which are subject to control, is a problem of the museums, and not a problem of the schools. These are the two assumptions—or doctrines—which have served as the *raisons d'être* of the experiments reported in this monograph.

Two broad generalizations of considerable importance for the continuance of such experiments have come out of our experiments. In the first place, the experiments have demonstrated time and again that the educational effectiveness of a museum visit is subject to change through the manipulation of conditions which are either directly or indirectly under the control of the museum authorities. We have experimented with the preparation of the children for the visit, with the use of formal illustrated lectures in the museum, with the methods used in presenting the museum exhibits to the children, and—indirectly—with the ability of the docent provided by the museum for the instruction of the children. In every instance, the experiments have shown that different conditions within any one of the four major categories result in differences in the amount of information possessed by the children at the end of the museum visit, or even long thereafter. These differences have not always been in the direction which was expected, and some experimental changes produced no measurable change in the effectiveness of the visit, but differences in effectiveness were the rule rather than the exception.

The second major generalization is that many conditions of the museum visit have various degrees of effectiveness as a function of the educational level of the visiting children, and perhaps as a function of the subject matter which the children are expected to assimilate. The most striking evidences of this dependent relationship were obtained when experimental variations were made in the method of instruction used by the docents in conducting the children through the museum halls. For example, the informal lecture method was clearly more effective than a discussion method in the teaching of fifth grade children, but children of the eighth grade learned about the topic of their visit when the discussion method was used. Apparently, one of the most important cues for future investigators is this intimate, although frequently puzzling, dependence of the effectiveness of certain educational methods on the educational maturity of the child.

At the present time the effective museum visit for school children can be confidently and precisely defined only with reference to those factors which have produced the same effects on children of all school grades between the fifth and eighth. It is now certain that all children who visit a museum for the purpose of learning about a subject which is not necessarily integrated with their school studies of the moment profit materially from a specific preparation for the subject of the visit. An effective preparation may be provided by a silent reading lesson which occupies 30 or 40 minutes of school time. This preparation is more effective the nearer it is to the time of the visit, but it may occur one week before the visit and still occasion a considerable increase in the amount of information possessed by the children at the end of the visit. A lengthening of the time spent in preparation, or the use of pictorial material in addition to the silent reading lesson, increases the effectiveness of the preparation.

The formal illustrated lecture is not a necessary part of the museum visits of children in the sixth, seventh, and eighth grades. Apparently, the time usually spent in listening to an illustrated lecture, if the lecture lasts for at least 15 minutes, may be equally well spent in direct contact with the exhibits. This holds true, even though the time normally spent in direct contact with the exhibits is long, e.g., one and one-half hours. Children of the fifth grade seem to benefit from a 15-minute illustrated lecture. However, none of the children used in these experiments profited more from a 30-minute illustrated lecture than from a 15-minute lecture and a tour of the museum which was increased in duration by 15 minutes. If the 15-minute lecture is used, it may be placed either at the beginning or the end of the visit when the docents lecture to the children during the tour of the exhibits, but it is probably most effective at the end of the visit when the docents employ the discussion method.

A simple and unconditional generalization regarding the relative effectiveness of the several ways in which the museum exhibits may be presented to the children is impossible. As previously indicated in our discussion of the dependence of the effectiveness of the teaching method on the level of educational maturity of the children, the customary lecture method has proved more effective than either the discussion or game card methods in the teaching of fifth grade children. With children of the sixth grade, the game card method appears to be more effective than the lecture method, and the lecture method appears to be more effective than the discussion method. Children of the seventh and eighth grades probably are most effectively taught in the museum when the docents employ a discussion method. For these children, the lecture and game card methods are not measurably different in effectiveness.

If the children who visit a museum are given appropriate preparation for the visit at an optimal time before the visit occurs, and are given the types of instruction in the museum which we have discovered to be most effective for children of their educational level, the effectiveness of their museum visit, from the educational standpoint, will surely be greater than it would be under other conditions. However, this statement assumes that the ability of the docents who instruct the children while they are in the museum is a constant factor. It does not follow, therefore, that one museum visit in which all these optimal circumstances are incorporated necessarily provides a more adequate educational service than another museum visit in which none of these circumstances are incorporated. Differences in the teaching ability of highly selected, and presumably well-trained, docents appear to be the most important consideration of all, and without an objective check on the success of the docents, a museum may be falling far short of the degree of effectiveness of which it is capable. One of the most important tasks for the future investigator in this field is the determination of the most satisfactory methods for selecting and training those who teach the children. This task should be given precedence over further experimentation with the methods to be used in teaching the children.

APPENDIX

In the following pages will be found exact copies of samples of the materials used in the investigations of the effective conditions of museum visitation by school children. The sampling procedure has been used since it is felt that there is no need for more than a demonstration of the kinds of things given the children in the form of silent reading lessons, lectures, docent talks, and examinations. The samples presented have been selected so as to represent all the verbal and written material given to the children of the lowest educational level tested, the fifth grade, and the highest educational level tested, the eighth grade. From these complete materials those interested may determine the extent to which the silent reading lessons have been integrated with the lectures and talks in the museum, how well the information tests have been adapted to the information given the children during the museum visit, etc.

PART A

Part A presents the materials used with children of the fifth grade. The materials include: (IA) instructions to the school teachers regarding the administration of the silent reading lessons and tests; (IB) a copy of the silent reading lesson and test on the subject of *Birds*, which was the subject of study for the children of the fifth grade throughout our investigations; (IC) a copy of the game card used in the schools in connection with the pictures and the silent reading lesson on *Birds*; (IIA) a verbatim transcription of the lecture on *Birds* which was given at the beginning or at the end of the museum visit; (IIB) a verbatim transcription of a representative talk given by one of the docents while conducting the children through the museum halls; (IIC) copies of the game cards used in the museum halls; (IID) a list of the discussion topics used by the docents when the discussion method was used during the tour of the museum; (IIIA) a copy of the true-false information test on the subject of *Birds* which was usually given immediately after the completion of the visit to the museum halls; (IIIB) a copy of the multiple-choice test which was sometimes given in the schools one week after the museum visit.

I. Materials Used in the Preparation of the Children for the Museum Visit.

A. *The Instructions to the School Teachers Regarding the Administration of the Silent Reading Lesson, the Test, and the Use of Pictures and Game Cards.*

Instructions to Teachers for Silent Reading on Museum Visit

FIFTH GRADE

Teacher's Name..........................School...................Room........

Date.................................Number of Pupils Taking Test............

The Silent Reading Lesson is to be given to your class during the reading period on the date above, which is just one week prior to the museum visit. This lesson has been prepared by a research member of the Buffalo Museum of Science in coöperation with the Buffalo Public School authorities. It is part of the research program being conducted to improve the service of the museum to the schools. Your cooperation will be appreciated.

In order to make the findings valid, close adherence to the following procedure is necessary. Part I of the Silent Reading Lesson should be distributed first. After the papers have been given out, the words defined on the first page should be pronounced orally It is suggested that the children use the word properly in a sentence. Following immediately upon the word study, the children should be told to read the Silent Reading Story carefully and then answer the questions. They may refer to the story in answering the questions.

Part II of the Silent Reading Lesson should follow Part I immediately. A museum game card should be distributed to each child in the class room. The answer to each question on the card may be found in the set of pictures provided. The pictures should be placed around the room, preferably at eye level. The children, with their museum game cards, should be allowed about fifteen minutes to find the answers. Special attention should be given to the arrangement of the pictures, so that the children will have ample room to study each one. (This paragraph deleted when pictures and game cards were not used.)

In order that conditions may be uniform in all schools, it is requested that no discussion (other than that necessary in connection with the word study) be permitted until after the test which will be given one week (or immediately) after the museum visit. This is not a test of individual performance, or of any class or school.

Please save the material in this envelope, and it will be collected at the time of the test in the schools. The space for scoring is provided for use in the schools if the Principal desires to have that information.

Part I: Silent Reading Test

Question	Number Wrong	Number Omitted
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		
Total		

Part II: Game Card

Question	Number Wrong	Number Omitted
I		
II		
III		
IV–		
1		
2		
3		
V–		
1		
2		
3		
VI		
VII–		
1		
2		
VIII		
Total		

B. *The Silent Reading Lesson and Test on Birds.*

SILENT READING LESSON ON BIRDS
BUFFALO MUSEUM OF SCIENCE
in coöperation with the
BOARD OF EDUCATION

Word Study

Museum—a place in which there are collected objects of interest which deal with nature, science and history.

Insect—a small animal without backbone that has six legs, and often has one or two pairs of wings.

Bill—the hard mouth parts of a bird often called beak.

Talons—strong claws used to catch live animals for food.

Protect—to take care of, or prevent injury to a thing.
Perching—sitting on a limb by grasping with the claws.
Webbed foot—foot with skin stretched between the toes.
Hawk—a large bird with strong claws and hooked bill for tearing flesh.
Heron—a long-legged bird that wades in the water.
Hatch—to develop a young bird from the egg.

A Story About Birds

When you go to the Museum next week you will see and learn much about birds. Birds are our feathered friends. They eat insects and weed seeds that destroy the farmer's crops. Most birds fly, but all birds have feathers. Some birds walk on their two legs, and some swim. Some birds sing beautiful songs and some have beautiful feathers.

You can tell much about what a bird eats from the looks of its bill. Birds with short strong bills use them to crack hard seeds. The birds that eat insects have longer and sharper bills. Some have bills that are very strong and sharp and hooked so they can tear flesh. They eat mice and so help mankind. Ducks are birds with broad flat bills for getting their food from water. Woodpeckers have strong bills to drill holes in trees to get insects they like to eat. Some birds catch fish with their long sharp bills. Others have long bills for digging in the sand or mud for worms and insects.

The feet of the different birds are suited to the place in which they live. Ducks have webbed feet for swimming. Perching birds like the robin have claws that hold tightly to the branches of the tree in which they sleep. Hawks have strong claws called talons for catching their food. Herons and other birds that live near the water have long legs for wading.

Some birds build their nests in trees; some build on the ground; some in bushes, and some in holes in trees. We should not disturb birds' nests in the spring and summer. If we do, the parent birds may leave the eggs and then they will not hatch, or they may leave the baby birds to starve to death.

Because birds are useful and beautiful we should protect them. We can protect the birds by not letting cats catch them, and by keeping bad boys from shooting them or robbing their nests.

A Test on the Silent Reading Lesson on Birds

After each statement in Column I, write the number of the correct expression from Column II to complete the sentence as in the following sample:

Column I		Column II
A We should protect most birds	2	1 because they have broad, flat bills
B Ducks can get their food from the water	1	2 because they are useful to man

Column I		Column II
A Birds with short strong bills		1 have long legs for wading
B Birds with webbed feet		2 catch live animals for food
C Birds that catch insects		3 drill holes in trees
D Some birds have sharp claws		4 build on the ground
E Most birds fly, but all birds		5 can swim
F Many birds that live near the water		6 are killed by cats
G Some birds build their nests in trees, while others		7 have feathers
H A woodpecker has a strong bill to		8 eat insects
I Very often young birds		9 have sharp bills
J We should protect birds, because they		10 can crack seeds

C. *The Game Card Used in the Schools in Connection with the Pictures of Birds. (This card is the same as the one used later in the Roosevelt Room of the Museum.)*

BIRD GAME

(Roosevelt Room)

I. The sparrow can crack the seeds it eats with its short strong bill. Find and name another bird that you think cracks seeds because of the shape of its bill. ....

II. Notice the bill of the robin which eats worms and insects. Name another bird you find whose bill looks as if it ate the same kind of food as the robin. ....

III. The marsh hawk is a bird of prey and has a strong bill for tearing flesh of mice, etc., that it eats. Notice the difference between this bill and the seed cracking bill of the sparrow. Find another bird of prey. You can tell it by the bill. ....

IV. Some birds swim, some birds wade, some birds use their feet for grasping.
1. The osprey uses feet for ....
2. The curlew uses feet for ....
3. The coot uses feet for ....

V. Some birds use their bills for digging, some for spearing, some for tearing.
1. The little green heron uses his bill for ....
2. The curlew uses his bill for ....
3. The osprey uses his bill for ....

VI. Birds of prey have strong claws or talons and hooked bills.
Draw a line under the bird of prey.
Marsh Hawk Kingfisher Blue Jay Thrush

VII. The kingfisher and the osprey are both fishermen.
The kingfisher uses his .... to catch fish.
The osprey uses his .... to catch fish.

VIII. Birds that live in swampy land where the ground is soft have their toes spread wide apart.
Underline the one that lives in the swamp.
Sparrow Robin Heron Cardinal

Name ....

II. FORMAL LECTURES, LECTURES BY DOCENTS, DISCUSSION QUESTIONS, AND GAME CARDS PRESENTED DURING THE MUSEUM VISIT.

A. *The 15-Minute Formal Lecture on Birds (Given in the Auditorium):*

"Birds and Their Habits"

"To the question 'What is a bird?' I believe your answer would be: 'A creature that flies.' We should have a rather definite idea as to what a bird really is before we step into the exhibition halls of the museum to study these creatures. (Slide 1.) The picture on the screen is one of an animal that most boys and girls have seen. It is a small creature somewhat like a mouse, its body covered with fur, but provided with two wings. I believe that all of the boys and girls in my audience would call this a bat and understand that it is not a bird. Were I to repeat the question, some of you would remember that birds have beaks and probably you believe that a sure way of knowing a bird could be found in its peculiar mouth. Let us see if this also would be the case.

(Slide 2.) "The next picture is one of a strange little animal that lives in Australia. It is also provided with a strange name which I think you must learn for you are to see an example of this creature in the museum today. It is called the duck-billed Platypus. This animal has its body covered with hair, possesses four legs like a cat or dog, but on its face we find a bill like that of a duck. Surely no one would mistake the Platypus for a bird.

"Again, some of you might inform me that one can know a bird because it is an egg-laying creature. Let us see if birds are the only egg-laying creatures. (Slide 3.) The picture before you shows very distinctly that certain snakes lay eggs and I should make it clear that we cannot tell a bird just because it is an egg-laying creature.

"There must be, however, some one thing which birds possess that distinguishes them from all other living creatures. And now let us attempt to describe what that is. (Slide 4.) We have here an illustration of a strange little bird that lives in New Zealand. The natives of that country call it kiwi. You are to see the kiwi on exhibition today and I would very much like to have you carefully observe that this bird differs considerably from sparrows and chickens, for example. First, you are to note that the kiwi has no wings. All birds, therefore, are not flying creatures and again, if I were to ask you what this bird is covered with, I am almost certain that your answer would be 'hair.' To find out if that can be true, let us first look at the picture of another bird. (Slide 5.) This is the little sparrow hawk which is common in Erie County and a bird that many boys and girls have seen. Were I to ask you what the sparrow hawk is wearing, I am certain that you would answer me correctly. The first important thing to remember about birds is the fact that all are covered with feathers and no other living creatures have feathers on their bodies. Even the kiwi is dressed in long feathers that resemble hair. Now we might define a bird as being a *warm-blooded, two-legged animal* dressed in feathers.

(Slide 6.) "The next picture shows part of a bird with which boys and girls in Buffalo are well acquainted. It is the skeleton of a pigeon. From the skeleton of a flying bird, we can learn two interesting and important things. Looking at the long bones as I point them out to you, I wish you to remember that these bones in the bodies of flying birds are hollow and filled with air. A bird in order to fly must first of all possess wings, but, secondly, it must also be very light and its hollow air-filled bones greatly reduce its weight. I do not believe that boys and girls really know what the wing of a bird is. We can find out by studying this skeleton. The long bone that I indicate is like the long bone in your own arm between your shoulder and your elbow; the two bones that you now are looking at are similar to the bones in your forearm; and, lastly, we see bones in the wing of the bird that are similar to those in your own wrist and hand. You can clearly see that the wing of a bird then is an arm and a hand hidden by feathers.

"Birds do lay eggs and most of them build beautiful nests. (Slide 7.) There is also a temptation when boys and girls find a nest like the bluebird's nest before you to touch the pretty eggs. That we should never do, for often merely touching the eggs of some birds will cause the mother to desert her nest. I am sure no boy or girl in my audience would willingly have such a thing happen. Let us see where some of the birds of Erie County like to build their nests and lay their beautiful eggs. (Slide 8.) In this picture we see the killdeer plover, which is one of a number of different kinds of birds that build nests on the ground. We should bear this in mind for in the spring and early summer when we walk and play in the fields and woods there is also the danger of stepping on a bird's nest. Children do not realize it, but every year hundreds of nests are stepped on by people and animals, and many thousands of eggs and baby birds are destroyed. Other birds in order to be safe build their nests in bushes or high up in the tree tops. (Slide 9.) The red-eyed vireo which is shown here is a common bird in western New York. It usually places its nest in a bush just about high enough for a boy to reach and because of this boys frequently molest the beautiful cradle of this bird. If boys wish to study birds' nests, they should wait until autumn. It is all right to take an empty nest to school but when a nest contains eggs or young birds, the only manly thing to do is to leave it alone. (Slide 10.) The Baltimore oriole which is a beautiful bird that comes to Buffalo to spend the summer often hangs its bag-like nest high up in a tall tree and boys have been tempted to climb into dangerous places to look at the truly wonderful nest. The result is that broken arms and legs are not uncommon because of this practice. It is best to avoid tree-climbing and leave all nests untouched.

"Birds are wonderful creatures that greatly aid us because of what they eat and we will now consider some of the useful feeding habits of our feathered friends. (Slide 11.) The picture is one of a handsome seed-eating bird called the rose-breasted grosbeak. Seed-eaters have short, thick bills like this one or like your canary bird at home. (Slide 12.) Here we see some seed-eating birds that migrate to Erie County to spend the winter; they are snow buntings. Let us see now how these seed-eating birds are helpful to man. If your father makes a garden, he is probably annoyed by finding weeds in it. In the picture, we observe the snow buntings feeding on seeds, the food they like best. The different kinds of seed-eating birds eat many millions of weed seeds during the year and every seed a bird eats is one seed less to grow in your father's garden.

(Slide 13.) "Other birds are insect-eaters and the one you see on the screen is the night-hawk a common bird that flies over the house-tops in Buffalo throughout the summer. This valuable bird, like swallows, catches its food while flying and many insects which we dislike, such as mosquitoes, are eaten by it. Still other birds are fond of caterpillars and one of these is shown in this picture. (Slide 14.) It is the little field sparrow. Most boys and girls in my audience realize that caterpillars are both annoying and destructive creatures. We can best understand how destructive caterpillars are by looking at a picture of their work. (Slide 15.) We have all seen the wagons spraying the trees in the city of Buffalo during the summer. That is done to poison the leaves in order that leaf-eating caterpillars may be killed. The pictures show clearly what a leaf looks like before a caterpillar begins its meal and what the same leaf resembles when the caterpillar has finished its dinner. If thousands of caterpillars were eating in one tree-top, the tree would be stripped of its leaves and that might kill it. It is too bad that we have not more feathered friends to aid us in getting rid of these terrible pests.

"Let us now consider a few owls, birds which are helpful to us because of another kind of food they eat. (Slide 16.) Owls, like hawks, include among other things they eat, rats and mice. This picture shows us some large and small owls. The larger ones would consume rats if they could catch them and all of them are very fond of mice, especially meadow mice which are very destructive in young orchards. Hawks and owls are truly the farmer's friend.

"Another reason for being fond of birds is their beautiful singing. (Slide 17.) The bird before you is the wood thrush who is a truly wonderful singer and a bird that because of his music makes life more pleasant for us during the spring and early summer.

"And still another reason for liking birds may be observed in this picture. (Slide 18.) Creatures dressed like our charming bluebird bring beauty to us and, while the bluebird is very handsome, there are other feathered creatures which come to Erie County to spend the summer that are still more magnificent. (Slide 19.) Look at this one! How many boys and girls realize that the scarlet tanager is a common bird in the woods of eastern New York throughout the summer? I trust that some day every one in my audience will have an opportunity to see this gorgeous scarlet and black bird.

"In this short talk, I have been trying to impress upon my young audience the fact that birds are excellent feathered friends. They do many things to make life better for us and it should, therefore, be our duty to aid and protect them. (Slide 20.) This is the picture of your pet cat, if you have one, and you all know just what kitty will do if she has the opportunity. In the spring when young robins are on the ground and unable to fly, your kitty will catch and eat as many of them as she can. If by watching her you can save the lives of a few young birds, it will be very much to your credit. The next picture is for the benefit of the boys. (Slide 21.) In the center we note a gun and I am very sorry to say there are altogether too many in the city of Buffalo. Even air-guns I regard as being dangerous but boys who do not possess air-guns usually have the implement that we see beside it and which you call a sling-shot. Look at the sling-shot, boys, and also look at the little dead bird which is shown in this picture. It is because I have seen boys in the city unmanly enough to shoot at birds that I speak of this. That is a wicked thing to do. You boys do not realize it, but, should some one kill a little motherbird in the spring or early summer, a whole nest of baby birds would starve to death.

"I want you boys and girls to think seriously about what I have told you today. Everything I have said is something that I would like very much to have you remember, but, most of all, I would like to have you think of birds as being wonderful little friends and my hope is that beginning now you will become good bird students and do your best to help the birds whenever you can."

B. *The Lectures by Docents in the Museum Halls:*

Hall of Niagara Frontier: Bird Alcove

"We are now in the Bird Alcove in the Niagara Frontier Hall. All the birds you see here have been found somewhere in western New York. What do most birds do in the autumn? Yes, they go south. Now, what do they do in the spring? They come north again. Who knows why the birds do this every year? As I feared, you answer: 'Because of the cold weather,' but a much better answer is the fact that the birds cannot find food when there is snow on the ground. If you could not have three meals a day, you too would go where you could find food in order to keep warm. The birds' travels thus are called migrations.

"The first case represents a spring migration group. We know that it is spring because the bushes are in blossom. These birds have just arrived from the south. There are two distinct types of birds in this case. Let us look at the white-crowned sparrows and the fox sparrows. Their bills are short and cone-like in shape. We can see that such bills would be very efficient in cracking seeds. Our sparrows are members of the finch family and all finches are seed eaters. Because we have weed seeds with us all the time, these sparrows can risk their return journey early in the spring. We find the song sparrow coming north as early as February. The finches are valuable birds because they eat tons of bad weed seeds.

"Now, let us look up in the branches and notice these little warblers with their fine pointed beaks. They could not crack a seed even if they wanted to do so. They are insect eaters and are valuable because they keep our trees and shrubs free from insects. Because the insects are late in appearing in the spring, our warblers do not return from the south until the end of April. They come in great droves during the month of May.

"Our next case represents some winter residents which remain with us all winter because they can find enough food on which to live. There is just one bird in this case which is not a seed eater. Can you find it? Yes, it is the winter wren. She has a tiny pointed beak similar to the warbler's. She finds her food by consuming insect eggs, scales and insects while in their pupa stage. All the rest of the birds are seed eaters. Let us name some of these. Here are the tree sparrows which we would see if we lived in the country during the winter. Next come five busy red polls. They are eating seeds from the bad Queen Anne's lace or wild carrot. They obtain their name from their reddish heads. Down in the snow is a demure snow bunting eating the seeds that fall to the ground. Tell me which is better colored for winter wear. The snow bunting or the red polls? Yes, the snow bunting is better because his brown back matches the twigs, and his white breast matches the snow.

"Let us look at this hemlock bough. The hemlock is an evergreen of which we probably know the hemlock, pine, spruce, and cedar. All pines bear their seeds in cones. These seeds are delicious to eat but are difficult to obtain, yet the birds we are now looking at are eating hemlock seeds. Notice the three cross-bills. Their bills are crossed in order to obtain the seeds from the cones. The grosbeaks have large bills and delight in opening the cone scales. The little pine siskins obtain their food in this manner also. Let me call your attention to the evening grosbeak which is very rare and comes north about once in seven years to visit us.

"Our next case shows ducks. These are not barnyard ducks but wild ducks found along the Niagara River and elsewhere in western New York. Notice they are sitting around an opening in the ice. Why? Do you think they are so fond of water? No, they are not going to swim. Ducks must have water in order to obtain their food. Some ducks are diving ducks and dive as far as 150 feet in order to eat aquatic plants and small animals, such as snails and clams. Other ducks are known as tip-up ducks. The tip-up ducks are sometimes known as river or pond ducks. The ducks in this case are all the sea or diving ducks. Let me introduce you to them. Here is Mr. and Mrs. Bufflehead, Mr. and Mrs. American Golden-Eye and Mr. and Mrs. Old Squaw. Notice in each case the father duck is more handsome than the mother. You will find this to be true in nearly all cases in the bird kingdom. The mother birds are dull in color because they have to incubate the eggs and protect the young. One more point of interest about ducks is that they have webbed feet for swimming and their flat bills serve them as strainers. When they get their food under the water, the sieve-like arrangement on the sides of the bill allows the water and mud to ooze out, leaving the food to be swallowed.

"Tell me what you find on the floor of the next case. Yes, sand, because this case represents a shore scene, and notice each bird as it runs along the sandy shore. Describe their legs in one word. Yes, it was easy to guess—'long-legged,' for they really are. Especially so are the yellow-legs and the curlews. Let us look at the kingfishers with their large overgrown beaks. They catch fish with their beaks and that is why their bills have grown so long. Their feet are very small and are used merely to perch on an old dead branch, although they do dig holes in the sand bank with them. Here is a friend of the kingfisher, a large bird of prey, known as the osprey or fishhawk. He has a hooked bill for tearing flesh, and strong feet or talons. He also is fond of fish, but he catches his fish with his feet.

"The next case represents a northern scene showing three unusual winter visitors. The goshawk, the snowy or Arctic owl, and the little hawk owl. The snowy owl came to us in great droves a few years ago. They were in search of food because the rabbits of the north upon which they usually fed were dying of a disease. However, we did not understand the snowy owl. We killed him because he ate a few pheasants and chickens. We did not realize that he was consuming many field mice which are very destructive. Perhaps next time when the snowy owl comes to us we will not be so cruel to him.

"The triple case at the end of the room represents a marsh scene, where many wading and swimming birds thrive. A marsh is a soft, muddy place where cat-tails and swamp-loving birds thrive. Notice the long legs on the great blue heron. These legs serve him well when in wading. He has a spearing bill and is just about to catch a leopard frog. The whistling swan should also be of interest as it visits our Niagara River every spring while migrating. The two other birds seen often on the Niagara River are the herring gull and the common tern. The two ducks which are shown flying are the male mallard and the male pintail.

"This case represents our permanent residents. They are our real friends, because they are with us every month in the year. Let us guess what the name of each bird is—crow, chickadee, blue jay, pileated woodpecker, red-headed woodpecker, male and female downy woodpecker, male and female white-breasted nut hatch, male and female bob white, and ruffed grouse. Notice that the bob whites and the grouse are ground-loving birds, and that their brown feathers match the brown leaves."

The Roosevelt Room

"In this room we find some very familiar birds and others related or associated with them. You probably remember that certain birds with short conical bills are fond of eating seeds. This English sparrow is familiar to everyone. He has made himself quite at home in America. He and the rose-breasted grosbeak, which I hold in my hand, have typical seed-eating beaks and are both, therefore, members of the finch group. The rose-breasted grosbeak is of great help to the farmer, not only because he eats bad weed seeds, but also because he consumes potato beetles. You can see that he would enjoy cracking a beetle with his strong beak, as if the insect were a seed.

"Here is our friend, the robin, a member of the thrush family. Baby robins are always spotted. This shows their relation to the thrush family. Many thrushes, like the wood thrush in my hand, carry their spots throughout life. Notice the similar beaks of the wood thrush and the robin. These birds can consume insects, worms, fruits, and seeds. Notice that the robin's breast is not really red nor is his back black. The breast is really a reddish brown color and the back is slate color. The robin also has five white spots.

"Let us look at this noisy fellow with the beautiful blue feathers. He is the blue jay, a cousin of the crow. We do not have jays very close to Buffalo, but they are quite common in our western New York woods. Both jays and crows have bills which are very stout and fitted for eating almost anything.

"Let us now take up the birds of prey. The marsh hawk is quite often seen in our district and so is the short-eared owl. All hawks and owls have hooked bills for tearing flesh and strong feet or talons for grasping. They are primarily flesh eaters, and that is how they get the name of *bird of prey*. Our marsh hawk sometimes finds and eats a snake, whereas the short-eared owl makes himself of great economic value, because of the many meadow mice which he consumes. Notice that the owl's eyes are large for seeing at night and his feathers are very soft, making him a noiseless flier. The term 'short-eared' refers to the tiny feathers which stand up on his head. Another and less common bird of prey is the American osprey, whose diet consists of fish. When getting his food he uses his talons to catch the fish. Sometimes while flying to a tree with a fish, a large eagle comes along and so frightens the poor osprey that he drops the fish, which the eagle immediately pounces upon. Here is another fisherman. Not a bird of prey at all, but the interesting little kingfisher. His feet are very small and so we know he does not use them for catching fish. He prefers catching his fish with his long strong beak. He consumes his fish head first, and several hours later coughs up the undigested fish bones. Many fish bones are often found in the kingfisher's nest, which is built six feet back in a sandbank.

"Here are some more birds associated with streams, ponds and swamps. Here are three typical wading birds; all with long legs and large feet—the American bittern, the little green heron, and the great blue heron. These birds do not sink in the mud, because they have large and wide spreading toes. They wade in ponds and streams in order to find crayfish, frogs, and fish. These they catch with their long spearing beaks. Sometimes in a pond one will notice a small gray bird swimming about. It apparently is not a duck, for its beak is short and colored red and white. This bird is no other than the American coot or the mud hen. It swims by means of its feet. You will see lobes on each toe. The coot is a shy bird, but one with which you should become acquainted. Still another bird associated with water is the long-billed curlew. This bird with its unusually long legs runs up and down a sandy beach and gets its food by probing into the wet sand with its long, partly flexible bill. It eats insects and small crustaceans.

"And now, boys and girls, I think you can understand how the kind of food a bird eats affects the shape of its bill, and the place where it lives, and how the way it gets its food often modifies its feet and legs."

The Bird Hall

"Form a big circle around the case. I want to tell you about these birds and their nests. Every kind of bird builds a different kind of nest. Where do birds build their nests? In the branches and trunks of trees, on the sand, among reeds and rushes. Where else? In bushes. First of all let us look at the one on the ground. It is the nest of the oven bird. His nest looks like an oven. It also has a roof over it so that when it rains the water runs off. See how carefully it is made. An oven bird's nest is difficult to see. Be very careful when you walk along the ground or climb up banks, because you might step on a bird's nest and crush the baby birds inside. Keep your eyes open.

"And here is the warbler's nest carefully woven with grass and hair. Now look at the nest of the cuckoo. What does he eat? He eats insects and worms and hairy caterpillars. Very few birds eat caterpillars, but the cuckoo eats hairy caterpillars. The cuckoo that lives in Europe does not build a nest but lays its eggs in other birds' nests so that they will take care of the young. The cuckoo, in America at least, has a nest of its own and brings up its own baby birds. Here is a gray bird with black on its head—the catbird. How many have ever seen the catbird? He is one of the most amusing and annoying birds there is. He can cry just like a cat. He scares all the rest of the birds. Besides imitating a cat, he can imitate the lovely songs of other birds. Look at his nest. The sticks are held together with mud. He made an attempt to line it with hair.

"Where do you suppose these birds live? Birds that build these nests are swamp birds. They are called rails. What is this bird? The hairy woodpecker. Look at that tree. It is a good hard solid tree. The woodpecker has been able to hollow it out with his bill. The hole at the top is for the entry. The woodpecker lays its eggs at the bottom of the nest. When you see a bird's nest with eggs in it, don't touch it, for even if the mother bird isn't in the nest at the time, somehow she knows it, and is apt to fly away and never come back again.

"Now I want you to see these birds. Does anybody know what they are? They are blackbirds but that is not the real name. Anyone know? They are bronzed grackles. They are very sociable. They go in flocks. They build their nests in regular villages. Here are the mother and father bird and two baby birds. What do you notice about the baby birds? They have very stubby tails.

"The flickers. How did you distinguish them from the other woodpeckers? By the white triangle on their rumps and the black and yellow stripes or bars on the wings. With the exception of the mother birds, they have mustaches. Therefore, you must think these babies are all boys. Both boys and girls have mustaches. The girls lose theirs when they grow up.

"What is this bird in the center? The scarlet tanager. The father bird is a vivid red and black. The mother is colored dull green to match the leaves. This is called protective coloration because her enemies cannot see her. And here is the indigo bunting. He and the swamp and song sparrows, as well as the rose-breasted grosbeak, have seed-eating bills.

"Here is the pileated woodpecker. This is a most unusual woodpecker. Look at all the holes he has made in this tree. This bird has been known to come as near to Buffalo as Hamburg. And here is a very beautiful scene of the red-shouldered hawk. All hawks are hatched early in the spring. Hawks and owls usually do not migrate, so when baby birds are hatched early in the spring, they are covered with down to keep them warm. And what is this the hawk has in its talons? A small mammal—the red squirrel. Don't feel sorry boys that the birds caught him, for he is a bad actor and steals birds' eggs. Hawks are birds of prey and have hooked bills and talons.

The Library

Since the children of the Fifth Grade were visiting the museum for the first time, they were shown the museum library. They were told something about the types of books available for children. With the higher grades, the time spent by the fifth grade children in the library was spent in another display gallery (See outline of materials used with the eighth grade children).

C. *Game Cards Used in the Museum Halls in Place of the Docent's Lecture:*

Hall of Niagara Frontier: Bird Alcove

A. Some birds swim, some birds wade, some birds use their feet for grasping.
  1. The osprey uses feet for ....
  2. The curlew uses feet for ....
  3. The coot uses feet for ....
B. Some birds use their bills for digging, some for spearing, some for tearing.
  1. The little green heron uses its bill for ....
  2. The curlew uses its bill for ....
  3. The osprey uses its bill for ....
C. Birds of prey have strong claws or talons and hooked bills.

$$\text{The} \begin{Bmatrix} \text{short-eared owl} \\ \text{marsh hawk} \\ \text{kingfisher} \end{Bmatrix} \text{is a bird of prey.}$$

D. The kingfisher and the osprey are both fishermen.
  The kingfisher uses its .... to catch fish.
  The osprey uses its .... to catch fish.
E. Birds that live in swampy land where the ground is soft have their toes spread wide apart.

$$\text{The} \begin{Bmatrix} \text{bittern} \\ \text{coot} \\ \text{heron} \end{Bmatrix} \text{lives in the swamp.}$$

Name ....

Roosevelt Room

I. The seed cracking bill of the sparrow is like the bill of the grosbeak, kingfisher, duck, cardinal, sandpiper.
II. Wading birds living along sandy shores have .... feet, ... legs, and .... bills for getting food.
III. The snowy owl, like other birds of prey, has .... claws called talons and a .... bill for tearing flesh.
IV. The spearing bill of the great blue heron is like or unlike the bill of the duck, who haunts the water holes for ....
V. The .... of the snowy owl .... it from the rabbits, rats and mice which it hunts.
VI. Female birds have .... colored feathers than male birds because ....

VII. The ground dwelling birds are colored .... to match the ...., ..., ...

VIII. The woodpecker chisels with his .... into the tree bark for ... .., uses his .... for a prop, and clings with his ....

IX. The robin, bluebird and Baltimore oriole are insect eaters. What food do the rest of the birds in the case with them eat? ....

X. Birds that regularly visit us for the summer, or winter and spend the other season in another section are called migrants. The ...., our smallest bird, comes to us for the summer from great distances.

Name..

Bird Hall

I. Some nests are built on the ...., some in ...., some in ...., and some in ....

II. The ovenbird's nest is built ....

III. The red-winged blackbird's nest is built ....

IV. The woodpecker's nest is built................................

V. The vireo's nest is built......................................

VI. Many materials, ..., ..., ..., ..., ..., ..., are used in nest building.

VII. Baby birds have very stubby .... until they have been out of the nest for some time.

VIII. How do you know that it is the mother redstart that is on the nest?

Name ....

D. Suggested Discussion Topics and Leading Questions to be Used by the Docents when the Discussion Method Was Used in the Museum Halls:

Hall of Niagara Frontier: Bird Alcove

(1) Tell us some features of birds that tell us what they eat, where they live, and how they live. Give examples. (2) What is meant by bird migration? Why do birds migrate? Point out and give the names of some of the migrants shown in the cases. (3) Explain what is meant by protective coloration. Name some of the birds in the room which are protectively colored. What is the importance of protective coloration to the bird?

Roosevelt Room

(1) Do all the birds on this table look alike? What makes them look different? (Get children to see that their legs, feet and bills are different; then let them find and point out any birds that have likenesses. Ask if they can tell the sort of place each inhabits, what food it eats, and how it gets its food.) (2) Have any of you boys and girls ever gone fishing? What did you take with you? (Lead to the osprey and kingfisher as examples of successful fishermen, and bring out the characteristics of each.)

Bird Hall

(1) If you were going to build a house what would be the first thing you would have to decide? (Where you would built it.) Having selected a place to build your house, the next thing to decide is ....? (What to build it of.) Give me reasons why certain birds select certain locations and materials for their nests. (2) Have you ever made a collection of birds' nests? What kind? Describe them. When should you collect birds' nests?

III. Information Tests.

A. *True-False Information Test Given at the End of the Museum Visit.*

Questions on Birds

Name .... School ....

Each of the following sentences is either true or false. If you believe that it is true, draw a line under the word TRUE, and if you think it is not true, draw a line under the word FALSE. For example:

Water is wet............. True False

Feathers are heavy........ True False

1. Birds are the only animals which are covered with feathers.......... True False
2. Most mother birds have more brightly colored feathers than the father birds.. True False
3. Ducks are fond of water, because of their great liking for swimming... True False
4. Snow buntings are helpful to man because they eat weed seeds........ True False
5. Birds are the only animals which lay eggs.......................... True False
6. All birds fly... True False
7. All birds build their nests in trees.............................. True False
8. The sparrow uses his strong short bill for cracking seeds............. True False
9. The little green heron with its large and wide spreading toes is a typical wading bird.. True False
10. The kingfisher has large and strong feet for catching fish............ True False
11. The robin, like the wood thrush, has a bill for eating insects.......... True False
12. The osprey has unusually long legs for running up and down the sandy beach.. True False
13. All hawks and owls have hooked bills for tearing flesh, and strong feet for grasping.. True False
14. The woodpecker has a strong bill for drilling holes in trees........... True False
15. Grackles, which are very sociable birds, build their nests in regular villages... True False
16. The scarlet tanager is known for its beautiful song.................. True False
17. The great blue heron uses its bill for spearing...................... True False
18. Birds have hollow bones to make them light........................ True False
19. Because insect food is scarce in the winter, the insect-eating birds spend the cold months in a more southerly climate than New York State.... True False
20. The loon is a northern water bird................................ True False
21. The oven bird gets its name from the shape of its nest............... True False
22. Birds that regularly visit us for the summer or winter, and spend the other seasons in another section, are called migrants................. True False
23. The house wren is the smallest bird about which we know............ True False
24. Flickers have exactly the same coloring as other woodpeckers......... True False
25. An animal that can fly, but is not a bird, is the bat................. True False
26. The red-eyed vireo, like the oriole, builds its nest on the topmost branch of a tree... True False
27. The robin is one of the most friendly of birds....................... True False
28. It is said that the blue jay has protective coloring, because it has colors which make it hard to see in places where it lives.................. True False
29. The white owl is a very common winter visitor in New York State.... True False
30. The sea ducks have little lobes of skin on their hind toes, which help them in diving.. True False

B. *Multiple-Choice Information Test Given in the Schools after the Museum Visit:*

QUESTIONS ON BIRDS

Name .... School ....

Draw a line under the correct answer or the word that completes the sentence correctly.

1. Birds are covered with
   scales fur shells feathers
2. Underline the name of the bird that can swim:
   robin woodpecker duck canary
3. Birds are the only animals that have
   a bill wings feathers two legs
4. A bird with a short strong bill suited for cracking seeds is the
   humming bird hawk sparrow robin
5. The woodpecker builds its nest
   in bushes on the ground on a branch in a hole
6. The brightest feathers are usually on
   the mother bird an old bird the father bird a young bird

Complete the following sentences using the four words: singing, bright colors, usefulness, night hunting:

7. The cardinal is noted chiefly for its ....
8. The owl is noted chiefly for ....
9. The hermit thrush is well known for its ....
10. The snow bunting is noted for its ....
11. We know the robin eats insects because it has a bill like a
    grosbeak duck heron thrush
12. A bird with a strong bill to drill holes in trees is the
    kingfisher sparrow woodpecker bittern
13. Swimming birds have
    bright feathers long legs webbed feet sharp bill
14. The longest legged birds are found in
    oceans marshes trees mountains
15. A bird that has colors which make it hard to see in the places where it lives most of the time is said to have protective coloring. Which of these four has protective coloring?
    thrush cardinal blue jay scarlet tanager
16. A bird that cannot fly is the
    bat ostrich goose gull
17. An animal that can fly but is not a bird is the
    rabbit oriole bat nighthawk
18. A bird of prey has sharp claws called talons to catch living creatures for food and strong bills to tear the flesh. Which is a bird of prey?
    swallow hawk killdeer grosbeak
19. Birds are our friends and we should protect them because they
    spoil cherries sit on the fence eat insects chirp
20. We call birds that come here every summer from the south
    warblers migrants finches singers

PART B

Part B presents the materials used with children of the eighth grade. During the five years of experimentation at the Buffalo Museum of Science, the children of the eighth grade were given instruction relative to three different topics: *The Invertebrates*, *Earth*

Science, and *The Story of Man*. Of the materials used in connection with these three topics we have selected for presentation here only those related to the *Story of Man*, since those materials not only adequately represent the general type of material given to the higher grades but also represent the lecture and discussion materials used in our major investigation of the relative effectiveness of the lecture and discussion methods. The only experimental variable used with the seventh and eighth grades and not represented here is the game card. Game cards were used in connection with the topic of *Invertebrates*, but were never used in teaching *Earth Science* or the *Story of Man*. This omission is not serious since the game cards presented in Part A represent adequately those used with the more advanced children.

The materials presented in the succeeding pages include: (IB) A copy of the silent reading lesson and test on the *Story of Man* (the instructions to the teachers regarding the administration of this lesson and test were the same for all grades, therefore the copy given on page 00 is representative of the instructions given to the teachers of the eighth grade children); (IIA) a verbatim transcription of the lecture on the *Story of Man* which was given in the auditorium at the beginning of the museum visit; (IIB) a verbatim transcription of a representative talk given by one of the docents while conducting the children through the museum halls: (IIC) a list of the discussion topics used by the docents when the discussion method was used in place of the lecture method in the tour of the museum; (IIIA) a copy of the information test given to the children at the end of the museum visit.

I. Materials Used in the Preparation of the Children for the Museum Visit.

A. *The Instructions to the School Teachers Regarding the Administration of the Silent Reading Lesson and Test:*

The same as used with the Fifth Grade children: See page 75.

B. *The Silent Reading Lesson and Test on the Story of Man:*

Silent Reading Lesson
on
Story of Man
BUFFALO MUSEUM OF SCIENCE

Vocabulary Drill

Primitive—pertaining to the beginning or simplest form.

Neanderthal—the name given to ancient cave dwellers characterized by a low type of skull and a large lower jaw.

Coup-de-Poing—a V-shaped hand axe made by striking off large flakes of flint.

Cro-Magnon—name given to a race of people living about 30,000 years ago. Their heads were long and narrow. The chin was well developed. Many beautiful paintings have been found on the walls of their caves.

Extinct—no longer existing.

Mammoth—name of a very large extinct elephant.

Archeologist—one who is devoted to the study of history from relics and remains of ancient people, civilization, or anything pertaining to ancient times.

Artifact—anything made or modified by man.

Palaeolithic Period—old Stone Age at which time the implements were chipped, rude, and unpolished.

Neolithic Period—the new Stone Age or Age of Polished Stone.

Travois—a frame to which dogs were hitched. It was used for carrying packages when the Sioux Indians moved camp.

Kayak—the Eskimo's small boat made of skins.

Umiak—a large wooden frame boat covered with skins, used by the Eskimos.
Assegai—an iron spear made by the Zulus.

The Story of Man

The story of man's progress upon the earth is very wonderful when one thinks of the difficulties which he has had to overcome, and the constant fight for life which he has had to endure.

Men lived on the earth thousands and thousands of years before they knew how to write. The people who lived before history was written are called prehistoric.

The earliest people about whom we know could use fire. These very ancient people lived in caves or cliffs. They did not know anything about metals. They worked only in stone, as was learned from the stone weapons which they left. For this reason we say they lived in the Stone Age. The skeletal remains show that Neanderthal and later Cro-Magnon man lived at this time.

Great beasts lived at the time when men dwelt in caves. Pictures of dangerous animals, such as the mammoth, cave bear, and saber-toothed tiger, scratched on bone, antlers, and ivory have been found among the utensils left by the cave dwellers.

In the same places are usually found rough, unpolished artifacts, such as coup-de-poings, spear-heads, arrow-heads, hammers, knife blades, and hatchets.

In the later Stone Age men learned to polish their flint and stone-weapons, and to sharpen the edges by means of grinding stone. This age is known as the Neolithic Period.

The ruins of houses built in the water thousands and thousands of years ago have been found in the lakes of Switzerland. We can read the history of the Lake Dwellers in the bones and broken pottery that have been preserved at the bottom of the lake. Hundreds of bones have been found, showing that man had tamed the dog, ox, sheep, pig, and goat. With the help of the dog, man hunted the bison, the wild boar, the cave bear, and the deer. With the help of the other animals he became a farmer and tilled the fields.

Not only did the Lake Dwellers live through the later Stone Age, but they knew the use of metals as well. Even today many people living in New Guinea and South America have their homes on stilts in the water. From studying these and their way of living, we can better imagine how the Lake Dwellers lived before history was written.

Scattered over the earth in various places are mounds which have been found to be full of shells and bones and other relics of early men or of their homes. By studying these we can find out, in another way, something of the early history of man.

The Mound Builders who lived along the Mississippi and Ohio Rivers showed some knowledge of sculpture, having carved forms of men and animals. Their clothing was in part the skins of wild beasts. However, in the mounds cloth has also been found, spun and woven from some material similar to hemp.

Spear-heads of flint, arrow-heads of quartz, flint knives, stone axes, hatchets of stone, rough and polished, are found in great numbers in these mounds. The mounds, it is believed, were used for the purpose of defense, as well as for temples and for the homes of priests.

There is still another way in which we can learn more about the people who lived before history began, and that is by looking at the tombs that they built. These great tombs found in many parts of the world prove that men living far apart, and at different times have passed through the same growth of ideas.

There are people living now in certain parts of the world who are still living somewhat as the prehistoric people lived. At the Buffalo Museum of Science you will hear about the Zulus, an African tribe of skilled metal workers. You will see the Sioux or Plainsmen with their characteristic travois and scaffold burial, and the Eskimos with their igloos, kayaks, and umiaks.

Test on Silent Reading Lesson

After each statement in Column I, write the number of the correct expression from Column II to complete the sentence as in the following sample:

Column I		Column II
A The Eskimos live in	2	1 bison
B The Plains Indians of North America hunt the	1	2 igloos

Column I		Column II
A The old Stone Age is known as the		1 artifacts
B A large extinct beast resembling the elephant of today is the		2 Zulus
C A V-shaped hand axe used in the old Stone Age is termed		3 cave paintings
D The new Stone Age is known as the		4 umiak
E The Cro-Magnons were known for their		5 archaeologists
F A vehicle used by the Sioux Indians was called a		6 Palaeolithic Period
G Tools and weapons made by man are		7 mammoth
H African natives famed for their metal work are the		8 coup-de-poing
I Men who study the relics and remains of ancient people are		9 Neolithic Period
J The large wooden boat used by the Eskimos is the		10 travois

II. Formal Lectures, Lectures by Docents, and Discussion Questions Presented during the Museum Visit:

A. *The 15-Minute Formal Lecture on the Story of Man* (*Given in the Auditorium*):

"The Story of Man"

(Slide 1: Scene in semi-tropical forest.) "The great majority of facts known about primitive man and his life come from discoveries in western Europe. From the implements and bones of both human and animal remains found in the caves of France, Spain, Switzerland, and other localities nearby, we know that before the coming of the fourth glacial period, the weather was very mild. Primitive man was first a nomadic hunter. During this early period, he camped along the river beds near a good water supply. His earliest implements and weapons were of wood and of stone, flint being most suited to his needs.

(Slide 2: Forest fire.) "How primitive man obtained fire is shrouded in mystery, but we think that he obtained it either from a forest fire that began as the result of lightning, or from an active volcano. We know that he handled fire far back in the dim days. He may have found that by rubbing flint against pyrite (or with quartz) a spark can be created. This can also be done by rubbing two pieces of wood together until friction ignites some nearby moss or shredded bark.

(Slide 3: Primitive snatching a fiery brand from a burning tree.) "Our early ancestors, after they had braved the capture of fire, soon learned that a stick could be pointed by partially burning it. This gave a sharp point for use as a weapon. The meat from wild animals was also improved by cooking in the fire. As the wild animals did not like the fire, early man found its use brought about some protection from them, and when the climate became colder, fire warmed his shivering arms and legs which were not covered by the skins of the wild beasts.

(Slide 4: Modern valley glacier.) "Life for primitive man had been rather simple until the fourth glacial period when adversity came upon his horizon in the form of glaciers. The early Stone Age hunter began to notice that the air of his forest was losing its tropical warmth. Scientists have not yet discovered why, but the climate grew colder, and, as the ages passed, the ice, which all the year round still overlies the region of the North Pole and the summits of the Alps, began to descend. (Slide 5: Map of Europe in fourth glacial period.) The northern ice crept farther and farther southward until it covered England as far south as the Thames. The glaciers of the Alps moved down the Rhone Valley as far as the spot where now the city of Lyons stands. The advanced portions of the glaciers are marked by the deposit of moraines. (Slide 6: Map of the farthest advance of the glacier in North America.) In North America the southern edge of the ice is marked by lines of boulders, our familiar 'moraines,' carried and left there by the ice. Such moraines are found, for example, as far south as Long Island, and westward along the valleys of the Ohio and Missouri rivers.

(Slide 7: Neanderthal man chipping flint in front of a cave entrance.) "The change in climate drove primitive man to the caves. Here we find him living a rough life, perhaps eating partly cooked meat, nuts, fruits, and roots, sleeping upon skins, and probably wearing skins for clothing, using sticks and fist hatchets or coup-de-poings as implements and weapons. In this picture man has been chipping flint by the oldest known method, that of percussion. Note the wooden club. (Slide 8: Picture showing percussion method of chipping flint.) This was more or less a hit and miss method, and how man ever made the usable weapons he did in this manner is a marvel. Try flaking flint yourself some time and see how difficult it is to accomplish. A stone hammer is used.

(Slide 9: Picture showing coup-de-poings (Boucher, fist axe) and other implements.) "Here are some early and later flint implements made by primitive man. Toward the end of the old Stone Age, the more advanced Cro-Magnon men got a much keener edge on flint implements by flaking them by the pressure method. In this way edges and points were made so that chisels, drills, hammers, polishers, and scrapers were prevalent. Bone, ivory, and reindeer antlers were carved by the Cro-Magnons who developed a fine artistic sense. (Slide 10: Picture showing pressure method of chipping flint.) "In this picture you can see that the pressure method made for greater fineness of workmanship and keener edges. The flint was 'chipped' by pressure with a bone or wooden implement. The last method of making weapons was to grind the edges down by sandstone or some other rough surface. All three methods are still used today by various native peoples.

(Slide 11: Neanderthal flint workers.) "Here are some Neanderthal flint workers interrupted from their labors by the approach of wild game. The elderly man with the white hair has a hand-axe in his fist, while a younger man has grasped a spear of wood and flint. The animals in the river appear to be woolly rhinoceroses.

(Slide 12: European animals of the fourth glacial period.) "With the advance of the glaciers, more northern animals came in. The southern elephant, the hippopotamus, and the sabre-toothed tiger migrated southward, their places being taken by the woolly mammoth, woolly rhinoceros, and reindeer. In this picture we see the reindeer and woolly mammoths. (Slide 13: A primitive man stalking the woolly rhinoceros.) In order to obtain food and clothing, primitive man had to hunt these animals, as shown here in this painting of the woolly rhinoceros in the American Museum of Natural History, New York City. Note the primitive man in the background.

(Slide 14: Primitive man hunting cave bears.) "The cave bear was also hunted for food. This scene shows how rocks and stones were man's first weapons. The cave bear, now extinct, was very large and a beast to be feared, so we think that primitive men must have hunted in groups for the fiercer animals. (Slide 15: Primitive man hunting the mammoth.) The killing of this cold-loving elephant not only gave man food and skins, but also plentiful ivory for spear points, ornaments, etc. These mammoths are thought to be the ancestors of the Asiatic elephants of today.

(Slide 16: Cro-Magnon men drawing mammoths on cave walls.) "We know about the animals the cave men killed not only from the bone and ivory ornaments and weapons we find, but also from the beautiful drawings, sculptures, and engravings discovered in over seventy caves of Europe. In addition, etchings are occasionally found on antler and ivory. Here the Cro-Magnons, those supermen who supplanted the crude Neanderthalers, are drawing mammoths upon their caves. Note the shoulder bone used as a palette.

(Slide 17: Picture of the bull in the cave of Altamira.) "Some years ago, a Spanish nobleman who was also an archeologist was hunting for artifacts on the floor of a cave on his own property. His little daughter, happening to glance at the ceiling, cried: 'Toros! Toros!' (Bulls, Bulls!). To his surprise there was a beautiful procession of bull bisons and other animals executed in colors on the ceiling. This cave of Altamira is now famous for these animal paintings which no human eye had beheld for at least ten thousand years until found by the little girl.

(Slide 18: Engraved reindeer.) "Here we behold a masterpiece of primitive art. It is a grazing reindeer engraved around a piece of reindeer antler. It was found in a cave in Switzerland and is a unique instance of the portrayal of a landscape in Palaeolithic art.

(Slide 19: Stag-hunters of the Neolithic Age.) "The New Stone Age found a race of people similar to ourselves with brown or light hair. They lived along the southern shores of the Baltic in the beginning of this period. They were known as stag-hunters and they are pictured here after a return from the chase. Note the hafted axe, and the three pieces of ornamented pottery. Also the wolf dog being held by the boy who wears a bear's tooth necklace. The stone edges of the tools of this period were ground on both sides.

(Slide 20: Lake-dwellers.) "In Switzerland some of the people of the new Stone Age built whole villages upon stilts in the water. Fishing was done by nets and also through trap-doors in the houses which were thatched. From the Orient came domesticated cattle and the idea of raising millet, wheat, and barley. The women did the first field work. The weaving of cloth and pottery-making were prevalent. Today we not only find the thousands of piles or stilts left from these lake dwellers' villages, but also grain, and the bones of dogs, oxen, pigs, sheep, and goats at the bottom of the lakes.

(Slide 21: Diagram of the succession of prehistoric ages in Egypt and in Europe.) "It was Egypt and southwest Asia that emerged into the historic period before any other section of the world. By the term 'historic period,' we mean the recording of important events by means of a written language involving an alphabet. History was now written for future generations. Southeast Europe entered the historic period next, and northwest Europe was quite slow in advancing. We owe much to the culture of the near East. Can you understand now why in the Neolithic Age, the lake dwellers of Switzerland and others learned about domesticated animals and agriculture from the Orient? The Nile River shown in the picture has played a leading rôle in the drama of agriculture.

(Slide 22: Lapplanders of northern Europe.) "Even today, we have primitive groups of people existing in this world. In northern Scandinavia and Russia, the Lapplanders live. They have two types of houses, the sod house, and the skin tent. From the reindeer, these people obtain transportation, milk, meat, and skins for clothing and tents.

(Slide 23: Eskimos.) "In northern North America, we have the Eskimos. In the summertime these people come south to kill the caribou (wild reindeer). They live in skin tents then. During the winter they go north to hunt the seals. Then the Eastern Eskimos live in igloos made of snow and ice, while the Western Eskimos construct plank houses for themselves. The Eskimo's small boat for one or two persons is the kayak and is made of skins. (Slide 24: Kayak and umiak.) They also have a large wooden boat known as the umiak. They hunt the seals with harpoons and the caribou with bows and arrows, and they burn seal-oil in stone lamps for heat. Their garments are carefully tailored from the skins of wild animals.

(Slide 25: Iroquois village scene.) "When Columbus reached America, he was met by the so-called Indians. Their industries were in the New Stone or Neolithic stage. Here is a stockaded Iroquois village. The timbers were sharpened by burning in the fire. The Iroquois were a group of tribes living in the woods of what is now central and western New York State. (Slide 26: Iroquois agricultural scene.) The women took care of the Indian corn or maize and also cultivated tobacco. In this scene, the men are working on a dugout canoe. The Iroquois also made smaller canoes of elm bark. Their weapons were of sharpened flint and wood and they resided in long houses made of bark.

(Slide 27: Sioux Indians.) "In the Middle West lived the Sioux Indians with their beautiful skin teepees upon which they often inscribed their picture language. All the Indians had dogs, and after the advent of white men in America, horses also became a part of the Indian's outfit. The horses and dogs were trained to pull the travois, a triangular vehicle without wheels. To the left is a scaffold burial. The Sioux Indians depended for their sustenance upon the famous American bison, which roamed the plains in great herds.

(Slide 28: Zulu village.) "One of the interesting primitive tribes in Africa is that of the Zulus. They live in villages encircled by a brush fence called a kraal. They are cruel and clever warriors, and from iron they have made a spear known as the assegai.

"These and other primitive races you will observe this morning on your tour upstairs."

B. *The Lectures by Docents in the Museum Halls:*

H. ll of Primitive Races

"On the left side of this hall as you enter are depicted some of the present primitive tribes living in the new world or western hemisphere. On the right side as you enter you will find primitive tribes of the old world or eastern hemisphere. By the term primitive, we refer to peoples who have not accomplished much along agricultural lines, and who, therefore, have to secure their food, clothing, and shelter in a crude and haphazard manner.

"The exhibit in Case 10 represents our conception of the later cave-dwellers called Cro-Magnons. These people often reached six feet in stature and had large brain capacities. They occupied the caves of western Europe, especially in France and northern Spain. They existed some thirty thousand years ago and were essentially hunters, having the reindeer, mammoth, ibex, bison, and woolly rhinoceros on their menus. Note the hunter entering the cave with an ibex thrown over his shoulder. These animals furnished skins which we believe the cave men used for clothing and for making their caves more comfortable. During their spare time, the cave men etched animal drawings on ivory, antlers, bone and even the walls of their caves. In these caves, however, the drawings are seldom if ever near the cave entrances as we see them here. Cro-Magnon men knew how to handle fire, and how to chip flint implements by the pressure method.

"In Case 9 are shown some primitive methods of obtaining fire. Of course, we have reason to believe early man obtained fire in the beginning from a volcano, from a forest fire, or from two broken tree limbs rubbing one upon another until the friction produced fire. The flint and pyrite method must have been used considerably by primitive men. Instead of pyrite, there are other stones such as quartz, that can be substituted. *The* *discovery of the uses of fire and the methods of making it marks man's most important advance above the animal kingdom.* Name some advantages of fire. (Pupils should answer (a) heating homes; (b) cooking food, and (c) manufacturing tools.) Notice the Eskimo with a block held in his jaws. Great pressure can be applied to the upright stick. A back and forth movement of the bow causes the stick to revolve.

"In Case 11 are some primitive weapons. The stone depicted in model No. 8 reminds us that this article from nature has always been man's simplest and handiest weapon. Note the use of the stone in the tomahawk of the American Indian (No. 3) and in the sling of figure No. 9. But including the stones, spears, harpoons, and all the rest, *the bow and arrow is the most effective and universal of all early weapons made by man.*

"In Case 12 is a model showing a primitive tribe living in northern Australia. They are called Murngins and the map with its red dots tells us the exact territory they occupy. We know that these people like the water for there are two dugout boats shown. A warrior and his weapons tell us that they attend wars, and the hunter coming in with a kangaroo gives us an idea of their food. They also kill and eat emus, pythons, sea sharks, flying foxes, crocodiles, porpoises, etc. The women hunt yams, lily bulbs, and seeds for food, after which they prepare them for the table.

"Case 8 shows us the Yaghans who live in a miserable, cold, damp region at the southernmost extremity of South America. (Points to map.) Their culture is meagre and crude. Despite the chilly weather they have little clothing, and their houses, which are either skin tents or huts made of boughs, afford little protection. Vessels made of bark are used. The boy in the background is practicing spear throwing using a bark bucket as a target while the woman in front of the hut is fashioning a bark utensil. The boat shown here is a bark canoe, but these people now have taken to the dugout canoes. For food, the Yaghans subsist in part on seals, whales, and wild birds which they snare. Note the whale bones on the shore and the customary fire built in the bottom of the canoe.

"In Case 6 we have the Waiwai tribe who live around the headwaters of the Essequibo River in South America. As you can observe on the map, this location isn't such a great distance from the Amazon River. We have learned that the Waiwai are rather light complexioned, hence the name of Waiwai which is an Indian word meaning tapioca. The few explorers who have visited and described the Waiwai tribe report that they are clean, industrious, and happy. Their conical, palm-thatched houses shelter several families and at certain seasons they also have the open shelter shown at the left. Their boats are both bark canoes and dugouts. Cassava roots which the Waiwai raise, form the principal food. Notice the woman grating the roots which lay alongside of her. Tapioca is cassava after the poisonous juices have been removed.

"Over in the Philippine Islands in about the same latitude as the Waiwai, we find the Kalingas living in a mountainous section of Luzon. Note in Case 14 the mountains painted on the background. These people live in villages which are sometimes in almost inaccessible spots on steep mountain sides. They too are clean, industrious, and well developed physically. Here again we see two types of houses. Strange to say the type raised only two feet from the ground is better built than the tree house which has to be entered by means of a ladder. The ladders are drawn up at night when an attack is feared. The Kalingas grow rice in irrigated fields. They also eat sweet potatoes, coffee, and cocoa. Notice the domesticated animals in the form of chickens, dogs, and pigs.

"In Case 16 is shown one of the most interesting tribes of Africa. These Zulus live in the southeastern portion. They live in villages which are encircled with a brush fence called a kraal. Note also that a low type of brush fence is employed within the village to confine the cows and goats. This is called a cattle kraal and is used by the animals at night. Note the painted hide suspended on the pole. It tells us that the head of the kraal is at home. The Zulus eat meat, milk, maize, Kaffir corn, and millet. Note the woman (at left) threshing Kaffir corn. The man near her is obtaining fire by means of a fire drill. The most outstanding fact about the Zulus is that they are skillful metal workers. They specialized in a short iron stabbing spear called the assegai. Some years ago, the Zulus were a powerful, warlike nation with a famous leader named Chaka. Their victories were many and they became world-famous conquerors. Today they are under the influence of white men and their power is gone. They are a broken nation.

"Not in the same latitude but with a very similar environment to the Zulus we find, as shown in Case 4, our Sioux Indians of the North American plains. They were a warlike, nomadic people existing chiefly by hunting. Some years ago, thousands of bison roamed in herds on our plains and it was these animals that the Sioux killed. It must be remembered that the American Indians did not have horses until they were brought over by the white people from Europe. From the buffalo and deer hides, the Indian women made teepees, bedding, clothing, etc. Rawhide bags called parfleches were made and decorated as we see the women doing here. Pemmican was buffalo meat dried and pounded and preserved for future use. Note the picture writing on the teepees, also the travois attached to the dog and to the horse. These were for the transportation of household goods. At the extreme left is a scaffold burial. The war bonnets of eagle feathers were worn only for war or at ceremonial meetings.

"When the Eskimo of northeastern North America is catching seals during winter, his home is temporarily a snow igloo. The model in Case 3 shows the construction of the igloo. The men are just completing the passage-way. The woman and baby within are kept warm by the burning of seal oil in stone lamps, and the cooking is done in a stone pot suspended over the lamp. Skins with the fur left on are used for clothing and bedding. Notice the bone snow knife for cutting blocks of snow. Below the snow igloo is a summer tent of caribou skins which in this instance is housing two families. During the summer months the Eskimo people come south and hunt the caribou by means of bows and arrows.

"Case 2 shows a winter Eskimo scene. Here we see them bringing in a seal which they have killed by means of a harpoon. Notice the type of transportation as provided by the dogs and sled. In the background raised on blocks of stone are stored the winter trappings of the Eskimo, high enough to be beyond reach of the wolves and other wild animals. Nearby is a kayak put up for storage. The skin covering has been removed, wrapped in bundles, and placed within the framework, again as a protection against wolves, foxes, etc. In the water is an Eskimo paddling a kayak, and on the shore you can see an empty kayak. The Eskimos also have a dugout boat called an umiak.

"Corresponding in latitude to the Eskimos in North America we have the Lapplanders of Northern Scandinavia and Russia. The Lapps in the model (Case 18) are the Mountain or Nomadic Lapps. They depend upon reindeer for milk, meat, clothing, and transportation. The reindeer has been trained to pull a sled which looks far more like a wooden boat, as shown in the model.

"Before leaving this gallery, I want you to be sure to notice the flint quarry in which some Iroquois Indians are obtaining chunks of flint to be fashioned later into tools and weapons."

Hall of Niagara Frontier: Indian Alcove

"This alcove represents the life of the Iroquois Indians who live here in New York State and who once, before the advent of the white people in this district, were very powerful. *Iroquois* is not the name of a tribe but of a group of five and later six tribes who banded together to establish peace among themselves and with all nations. The Senecas (Keepers of the Western Gate), Onondagas, Oneidas, Cayugas, and Mohawks (Keepers of the Eastern Gate) comprised the original five nations. Later the Tuscaroras came from the south and joined them, forming the sixth tribe. This 'League of Nations' was one of the best organized leagues ever formed, and it made the Iroquois an outstanding people.

"The Iroquois Indians made their houses of elm bark laid on in strips over a framework of poles. At the left you will see the type of house built in the early days before the formation of the League of the Iroquois (Case showing Iroquois long house.) At that time many families banded together for protection, and so we find a real Indian apartment house. These houses were about one hundred feet long, which is about as long as the main hall down the center of this museum. They were called 'long houses.' In later years when it was no longer necessary to live in such close quarters for protection, the Iroquois built 'long houses' for ceremonial lodges, and the term 'long house' came to be a symbol of the unity of the League. This 'long house' model that you see is symbolic of the League of the Iroquois because it shows five fires, representing the five original tribes of the Iroquois. Notice that it is built something like a pullman train, with berths on either side of a central passageway. Each family occupied two berths if necessary. If a 'long house' had five fires it would hold five or more families. Notice the storage space just above the beds for things not in use. These shelves held dried fruits and vegetables, such as corn, squash, and beans. It might also hold the lacrosse sticks for the Indian's favorite game, lacrosse, which is something like hockey. Also his snowshoes.

"Now let us look at the scene where the Indians are stripping bark from an elm tree (scene in woods). The Indians used elm bark for houses, canoes, and also for baskets and pails. These Indians have built a scaffold so that they can strip the bark in sheets after it has once started to peel. Bark was stripped before June so that the sap would still be in it, making it soft and easy to work with. When bark dries up it curls and becomes brittle, so it was kept moist until used. Notice the bark sweat-house in which the steam is held in by the skins.

"The Indian in the center of this group has killed a wild turkey. He has a blow-gun in his hand which was used for smaller game. This hollow tube was put to the lips, and the Indian blew a light arrow through it. He could kill a rabbit at 100 yards with a blow-gun.

"The Indian on the left is cutting down a tree by means of a fire. The Indian did not have steel axes such as we have and it would have been a long and difficult task to chop down a large tree with a crude stone axe, so he used a slow-burning fire which was prevented from spreading by packs of wet mud. In the next exhibit we see what he is going to make of the trunk of the tree.

(Field and canoe scene.) "Here we find two Indians making a dugout from the trunk of a tree. They have built a slow-burning fire in this log to char the wood so that it may be scraped away. Here also the fire is prevented from spreading by using packs of wet mud. Sharpened stone tools called gouges were used to hack away the burnt wood, and occasionally clam shells were used for this purpose. It was a long and tiresome task. Since these Indians had no metals as modern people do, but used stone or bone for their sharp instruments, we learn that they were in what is known as the New Stone Age (Neolithic) when the white people landed in the Americas.

"Notice the maize growing in the fields. The Iroquois Indians were great agricultural people, but it was the women who planted the fields and took care of them. The men did the hunting, fishing, and fighting. Maize or Indian corn was the principal food of the woodland Indians, just as bread is our staple food. It was the Indians who taught the white men the use of maize and showed him how to grow it. Here you will see the maize is planted in little hills. The Indians also planted beans in the same hills so that the bean vines could climb upon the corn stalks. They were still more economical of space, and often planted pumpkins or squash at the foot of the hills. These three vegetables were called the Three Sisters since they always grew together. Besides the foods I have named the Indians ate much the same food as you see growing today on our farms, such as apples, cherries, strawberries, nuts, etc. There were, however, two exceptions; the peach and the pear were brought in from Europe. The Indians cultivated large quantities of sunflowers and tobacco. Note the man with the fish. You can easily see that they had fish, wild birds, and wild game such as squirrels, bear, deer, etc. Note the shed which is used for storing corn.

(Village scene.) "Now let us look at this typical Iroquois village scene. We can see that this village is of a more recent period than the old days before the League, because the bark houses are smaller. Only one or two families occupied each house. The Indians were safer after the formation of the League so they could spread out a little. Note also that the houses are not built on streets but face in all directions. At the right you see a house being built. The long poles have been sharpened in the fire. Since the Indians had no nails (nor any of the metals for that matter) they tied the poles together with either deerskin thongs or with basswood bark made into thongs. See the pile of elmbark which is used to cover the framework. It is being held down with stones to keep it from curling. The Indian houses had no chimneys. A hole in the roof let out the smoke. Chief occupations in and around an Iroquois village were making pottery and baskets, tanning skins, and making clothing and ornaments.

"In the rear you will notice a high fence or stockade around this village, made of sharpened poles. This stockade protected the village from attack by wild beasts or enemy tribes. The platform around the inside of the stockade was used as a lookout for sentinels or guards and also came in handy when the village was being attacked. (Artifact exhibit.) Here is a belt of wampum or Indian money, made from purple and white shells. Also the horn rattles which were used in dances. And see the flute, the Indian's only musical instrument outside of the drum and rattle. Indian young men would play the flute for their lady friends in the evening, and sing to them, for Indians had good singing voices. Notice the wooden spoons, bone awls, or needles, pottery, and celts."

Hall of Civilization

"If it had not been for the development of agriculture, we would not be able to enjoy the benefits of civilization. But with the growing of crops, primitive races began to live a settled life. Homes were improved, household goods accumulated and certain members of the family had spare time in which to develop basketry, pottery, and weaving. The passing of nomadic life allowed for the domestication of plants and animals which increased man's comfort and helped make his burdens lighter. A fixed home not only allowed for the accumulation of personal possessions, but it led to ownership of land.

(Exhibit showing rice culture.) "Let us start here with rice culture in the Philippines. Rice is the principal food of the Oriental peoples. In northern Luzon where it is mountainous, rice is grown on artificial terraces. The natives can irrigate by letting water flow from one level to another. The scene here shows the natives transplanting the rice sprouts. The water buffalo is helping the soil turners prepare the terrace, while other men are transplanting rice stalks brought from nearby nursery beds. In a few moments we shall see a marvelous civilization built upon the benefits derived from rice culture.

(Exhibit showing the story of wheat.) "How early man discovered that food can be grown by sowing seeds will never be known. We can surmise different ways, and here is one idea as to its discovery. A group of relatives have returned to a grave upon which they had scattered wheat seeds for the spirit of the departed one. Imagine their amazement when they find the grave covered with growing stalks of wheat! (Exhibit showing Indian maize or corn.) Many of the foods you eat today were not known until the white men discovered America. It is from the Indians that we obtained maize, beans, squash, potatoes, tobacco, tomatoes, and other plant products. Here we see the Hopi Indians of Arizona where the climate is known to be very dry. In order to have enough water in the spring to keep the maize field yonder in good condition, we here witness the Indians going through their flute dance to perpetuate the constant flow of water. Indian corn or maize was the principal agricultural product of the American Indian. Years ago these Indians built their villages (pueblos) on top of the table lands (mesas). Look carefully and see if you can find a pueblo shown in the background of this exhibit.

(Exhibit of pottery.) "The need for suitable receptacles to contain liquids and foods for storage, cooking, or serving led to pottery. Its discovery was no doubt accidental. Baskets lined with clay or pitch, etc., could be made to hold liquids. This led to the moulding of clay. Then, by accidentally leaving it too near a fire, the clay was baked or 'fired' and the first bit of pottery made. Shaping by means of gourds, with baskets, or by hand using coils of clay seemed to be the most popular methods. The decorations of pottery came next and so artistic tendencies soon gave birth to real art. Later the potter's wheel and glazing followed, ending finally in the discovery of porcelain. (Exhibit showing primitive types of homes.) Let us look for a moment at these primitive types of homes. The first shelter was the cave shown at the upper left. We know that the Neanderthal and Cro-Magnon men of Western Europe thousands of years ago lived in just such shelters. Look next at the home of the lake dwellers who lived during the New Stone Age in Switzerland. This home was built upon stilts over the water. It had a trap door through which fishing could be done. The sides of the house were of wattlework while the roof was thatched. The people also caught fish with seine nets shown here hung up to be dried, and they had dugout boats as the model shows. Now let us look at some American Indian homes. Here is the teepee of the Plains Indians built of bison hides covering poles; the hogan of the southwestern part of our country is used by the Navajos, while the adobe house made of sun-dried bricks (also of the southwestern part of our country) is used by the Pueblo Indians. The bark cabin on the right is from the northeastern part of America and is used by the Algonquins. Far to the north but, still toward the northeastern portion of our continent, we find the snow igloo of the Eskimo which is used when he is employed in harpooning the seals during the winter. From central Asia we learn of the felt-covered frame house called a yurt, and we have always been familiar with the thatched hut of the tropics. The pioneers of our country made log cabins chinked with mud, and every American knows that one of our greatest presidents first saw the light of day in one of these homes. The stone house with sod roof from southeastern Europe is another well built type of home.

"In these three exhibits we have represented the height of three ancient civilizations based on the three great crops, rice, wheat, and maize or corn. (Model of Boro Budur.) In Java, a few hundred years after the time of Christ, we find the temple of a thousand shrines, considered the mightiest monument ever erected to Buddha. It is emblematic of the height of Buddhism about one thousand years ago, and the scene showing the temple called the Boro Budur is supposed to represent that time. Notice the arrival of visiting pilgrims and the tame Asiatic elephants which are being used for transportation. At the left can be seen the flooded rice fields and the natives with their water buffaloes at work.

(Model of the pyramids of Egypt.) "The Nile River shown at the right of this exhibit annually floods its valley. As the waters subsided, wheat was sown. The people of the Nile valley (Egypt) became a wealthy nation from the culture of wheat, the food on which the people subsisted. Three thousand years before Christ, we see them here building huge tombs called pyramids for the deceased royalty. The second great pyramid at Gizeh is shown here under construction. It is being built of sandstone blocks which are later sheathed with a limestone facing. Notice that there are no beasts of burden to assist in the work which is being accomplished. It is said that one hundred thousand slaves worked on this pyramid for thirty years. Note the four black Ethiopians carrying the queen's chair. The Egyptians are bronzed colored and members of the white race.

(Model showing Mayan civilization.) "In our own Central America three hundred years after Christ, there flourished one of the most advanced of the ancient civilizations. This civilization was built upon the culture of maize or Indian corn. Here we see the main plaza of the ancient city of Tikal during a religious ceremony. Tikal possessed nearly one hundred public buildings and temples, the temples all having what is known as a pyramidal style of architecture. Notice the fires high up on the temple platform. Through the window at the right may be observed a Mayan astronomer-priest sighting a star by the cross-stick method. The Mayans developed the science of astronomy to a mathematical precision.

(Exhibit of money.) "Primitive peoples acquired wealth either by creating it or exchanging it through barter. An exchange of surplus materials was bartering. This was the first step in the story of money. As civilization advanced, a convenient medium of exchange became necessary, this medium of exchange to represent standard values and thus to facilitate the growth of commerce. Some three thousand years ago, coined metals came into use as a medium of exchange. Since then the metals have dominated all other articles of exchange and are now the money made from sea shells (see picture). Note in the money exhibit several moneys that were and still are used but which are not metals. As examples may be listed grain, cocoa beans, fish hooks, cheese, chocolate, tea, tobacco, salt, shells, amber, whale teeth, feathers, and flint arrow heads. (Exhibit of writing.) "With the development of civilization came the idea of a written language. Writing probably grew out of the need to transfer an idea from one mind to another at a distance. The recording of important events and information thus made possible the accumulation of knowledge and its preservation for the benefit of generations to come. Writing originated from the pictures which primitive man carved on bone or painted on his cave walls (see picture). Primitive man had little need for writing, but when life grew complicated and it became necessary to identify individuals and property a kind of writing called pictograph writing was evolved. In it a series of pictures was written on stone, skin, or wood and these pictures told the story. The pictures were simplified and abbreviated so as to emphasize only the significant details of the object. The writing of the early Egyptians and Chinese and of the North American Indians was pictographic. From the pictograph came the ideograph which was a symbol of the picture. Mayan, ancient Chinese, and Egyptian writing have a large ideographic element. From this stage, phonetics were developed. Finally alphabet writing was adopted in which each sound in the language was represented by a separate symbol. The Phoenicians are credited with the invention of the alphabet."

Hall of Man

"These three cases (Nos. 3, 4, 5) are devoted to the basketry of western American Indians. The Indians of California and our west coast were noted for their baskets which displayed expert workmanship, fine texture, difficult designs, and the use of beads and feathers. The Pomo Indians, in particular, used feathers in basketry. There are fundamental reasons for basketry becoming so well advanced on the west coast. First, in contrast to the Plains Indians who were always chasing bison and the woodland Indians of the North who were always hunting in the forest, the Indians of California lived a comparatively sedentary life and so had the time and inclination to do elaborate hand work. Second, since their food consisted chiefly of berries, vegetables, nuts, etc., which had to be gathered in the field and forest, they needed a great many baskets for carrying purposes. Third, the warm California climate was favorable to sedentary arts.

"In Case 6 are Navajo rugs. After the Spaniards had introduced sheep, the Navajos learned weaving from the Pueblo Indians. These blankets in bold designs and gay colors are primitive examples of tapestry weaving. The Navajos always used fancy designs in their rugs, (due in part to white influence) while the designs of the Pueblos are along straight lines and quite simple.

"In Cases 7, 8 and 10 are Hopi Katchina dolls. The Hopis belong to the Pueblo Indians. The Hopis live in northeastern Arizona where the climate is dry. The carved and painted Katchina dolls represent the spirits who bring the summer showers for the Hopi crops. Every summer the Indian men dress like these dolls and go through their famous rain dance. The medicine men who have made the dolls, give them to the children during the dances. The little Indian children do not play with the dolls as American children would, but hang them upon the walls or from the ceilings of their houses. In other words, they just gaze at them. Note the cloud and rain symbols which appear somewhere on almost every doll.

"In Case 9 is a man's costume of the Plains Indians. It must be remembered that the Plains Indians (Sioux or Dakota, a family name for many tribes) had the bison (buffalo) for a mainstay. The food was almost exclusively bison meat; the horns were used for many things such as cups and spoons; the fur-covered skins were used for robes; and the hides were used for clothing, bedding, teepee covering, etc. This scalp shirt is made of deer-skin. It is beaded with white man's beads, showing a modern influence. In the early days it might have been decorated with paint or porcupine quills. Note the typical shape of the jacket, with the border down the sleeve and the design in front. This design might be the Indian's individual totem. The common practice in the early days of taking scalps led to the scalp shirt which originally had scalps attached to it as symbols of courage. Later, tufts of human hair replaced the scalps for decoration. Note also that the leggings were also trimmed on the border or edge. These are typical Plains moccasins with the stiff soles (tough buffalo hide) in contrast to the soft soles of the woodland Indians' footwear. We find that the Plains Indians in their beadwork had solid designs, while the woodland Indians of the East who saw many flowers, plants, and tree leaves, had floral designs done in outline form, only occasionally filling in the flowers with solid beadwork.

"The Navajo sand painting on the table in the center of the room was for the cure of a sick person. The art of sand painting is one of the very oldest arts, having been practiced from the beginning of time. Sand paintings were used in the healing ceremonies of the tribe. Medicine was an all important factor in the life of an Indian. Diseases were caused by the Devil or by devils. The only way to handle them was to (1) ridicule the Devil by painting a caricature of him and thus chasing him away; (2) draw animals, signs, etc., to pacify him; or (3) scare him away with hideous noises, faces, and dances. This painting does some of these things. Let us pretend an Indian boy has fallen ill. The medicine man and his assistants are summoned. They appear at the boy's lodge early in the day. They smooth off a space in the center of the lodge, and the designs are made on the floor. The sand painting is made exactly according to the directions that have been handed down from generation to generation. The medicine man uses the different colored sands that he has obtained from the painted desert. He works all day until about 3 P.M. The design of the sand painting is very intricate, consisting of figures representing the deity and other figures and symbols which are determined by the disease that is being treated. Each painting has a magic significance. Few white people have ever seen a real sand painting as the potent symbols are always omitted when there is the possibility of it being observed by white people. The painting has to be completed and then destroyed by sundown. When it was finished the sick boy would dance on it, or if he were too ill, they would place him on it in a stretched-out position after which the men might dance on it. After all this work, the boy was supposed to be cured. A Navajo sand painting could never be left undestroyed over night.

"The sand painting on the table near the door is more complicated but just as interesting. The painting represents the Navajo prayer for corn. You should come to the museum sometime and study out the meanings for the colors and figures in this painting. The meanings are given in the label."

C. *Suggested Discussion Topics and Leading Questions Used by the Docents when the Discussion Method Was Used in the Museum Halls:*

Hall of Primitive Races

(1) From observation of the Cro-Magnon cave, do you know how anthropologists have learned about these people? (2) How many methods of making fire do you know? Name some advantages of fire. (3) Give me some reasons why weapons were developed. (4) From the Yaghan exhibit, what can you say of the culture of these people? (5) What is a kraal? Where do you see one? What other interesting facts do you know about the Zulus? (6) Look closely at the Kalinga exhibit and then discuss the culture of these people. (7) What interesting facts do you know concerning the Indians of the North American plains? (8) Discuss the importance of the reindeer to the Mountain Lapps.

Hall of Niagara Frontier: Indian Alcove

(1) What is meant by the Iroquois 'long house'? (2) Describe the method used by the Iroquois Indians in cutting down trees. (3) What part did the women play in the livelihood of the Iroquois Indians? (4) Describe a typical Indian village scene.

Hall of Civilization

(1) Name and describe a civilization built upon the benefits derived from rice culture. (2) What did the flute dance signify for the Hopi Indians? (3) How many different types of primitive homes can you name and describe? (4) Who can briefly give the history of writing?

Hall of Man

(1) Discuss the Indians of California as to their form of living. (2) What do the Hopi Katchina dolls represent? Describe them. (3) Can you give me a picture of the Eskimo's manner of living?

III. INFORMATION TESTS.

A. *Short Form Multiple-Choice Information Test Given at the End of the Museum Visit:*

QUESTIONS ON THE STORY OF MAN

Name .... School ....

Underline the word which best answers or completes each of the following sentences:

1. It is believed that the most important discovery made by man was
   pottery gold fire wheat
2. The animal which is of unusual value to the Mountain Lapps is the
   reindeer mammoth bison horse
3. The interior of an Eskimo's snow hut is heated by burning
   wood seal oil kerosene oil gas
4. The discovery of pottery was important as a means of
   decoration storing food amusement trade
5. The Cro-Magnon Man lived in
   tents straw huts igloos caves

6. The civilization of the Philippines depends on
   fish wheat corn rice
7. We believe that Cro-Magnon Man lived about
   150 years ago 1,000 years ago 30,000 years ago 200,000 years ago
8. The name of the Eskimo's small boat made of skins is the
   kayak umiak barter caribou
9. The Iroquois Indians cut down trees by means of a
   steel axe fire saw hatchet
10. Indians of Northern and Southern California were famed for their
    basket making beautiful homes bison hunts kraals
11. Much has been learned about Cro-Magnon Man from his
    pottery basketry cave paintings agriculture
12. The Iroquois 'long house' was covered with
    skins bark earth sun-dried brick
13. The Mayans contributed many facts to the science of
    geology pottery astronomy physiology
14. The Kalingas live in about the same latitude as the
    Mountain Lapps Murngins Sioux Waiwai
15. Alphabet writing was invented by the
    Chinese Egyptians Hebrews Phoenicians
16. The most efficient and universal of all weapons made by early man is the
    bow and arrow boomerang war club blow gun
17. The huge Egyptian tombs for the burial of royalty are called
    Boro Budurs Mounds Pyramids Scaffolds
18. Sioux Indians used rawhide to make bags known as
    cassava teepees parfleche travois
19. The Yaghan Indians live in a desolate region in
    Western Australia Southern South America
    Western Africa Eastern Mexico
20. The Mayans lived in
    South America Egypt Central America Asia
21. The Hopi Katchina dolls represent the Spirit that brings
    evil rain sunshine bison
22. A system of coinage was necessary for the development of
    agriculture science commerce navigation
23. The adobe house made of sun-dried brick is characteristic of the
    Navajos Pueblos Algonquins Iroquois
24. A V-shaped hand axe made of stone by early man was the
    harpoon assegai coup-de-poing spear
25. The New Stone Age or Age of Polished Stone is the period known as
    Paleolithic Neolithic Neanderthal Altamira

B. *Long Form Multiple-Choice Information Test Given at the End of the Museum Visit:*

QUESTIONS ON THE STORY OF MAN

Name .... School ....

Underline the word or phrase which best answers or completes each of the following sentences:

1. It is believed that the most important discovery made by man is
   pottery wheat fire gold
2. The interior of an Eskimo's snow hut is heated by burning
   wood seal oil kerosene oil gas

3. The settled community was made possible through the discovery of
   pottery writing science agriculture
4. Indians of Northern and Southern California were famed for their
   beautiful homes basket making bison hunts kraals
5. The discovery of pottery was most important because it provided a means of
   decoration storing food amusement trade
6. The civilization of the Philippines depends on
   fish wheat corn rice
7. All human races have struggled to obtain
   food, shelter, and clothing beautiful buildings
   weapons preservation of forests
8. The Iroquois Indians cut down trees by means of a
   fire steel axe hatchet saw
9. Money was necessary for the extensive development of
   agriculture science commerce navigation
10. Much has been learned about Cro-Magnon Man from his
    pottery basketry paintings agriculture
11. Many Indian tribes made their clothes of
    wool hides silk cotton
12. Commerce began by a simple exchange of
    gold products of labor silver paper money
13. The Mayans contributed many facts to the science of
    geology biology astronomy physiology
14. Most of the domestic implements of the Mountain Lapps were made of
    metal wood pottery stone
15. The blanket weaving of different Indian tribes was usually
    of the same coloring of the same form
    of a variety of designs of equal simplicity
16. The animal which is of unusual value to the Mountain Lapps is the
    reindeer mammoth bison horse
17. The most efficient and universal of all weapons made by early man was the
    boomerang bow and arrow war club blow gun
18. The name of the Eskimo's small boat made of skins is
    kayak umiak yacht skiff
19. The shelters of peoples in various parts of the world depend primarily on
    the availability of straw the climate
    the availability of lumber their mathematical ability
20. The bison dried-meat mixture is called
    pemmican hogan yurt umiak
21. The Indian woman was
    the hunter the farmer the fighter the religious leader
22. We believe that Cro-Magnon Man lived about
    150 years ago 1,000 years ago 30,000 years ago 200,000 years ago
23. The discovery of agriculture came to different races
    in the same way in different ways
    during the Steel Age during the Old Stone Age
24. The principal food of the Waiwai Indians is
    sugar cane corn cassava root fish
25. The American Indians had
    superstitious ideas one God
    simple religious ceremonies elaborate churches

26. It is a Navajo Indian custom to have sand paintings last for
    one day   two weeks   one month   one year
27. The recording of history began with
    science   writing   agriculture   archaeology
28. The Zulus were skillful
    fishermen   metal workers   builders   weavers
29. Man excels all other animals in respect to
    hearing ability   seeing ability
    reasoning ability   speed of running
30. The Kalingas live in about the same latitude as the
    Mountain Lapps   Murngins   Sioux   Waiwai
31. The sign language is
    not used today   the only form of communication of some peoples
    sometimes used today   used only by Indians
32. The huge Egyptian tombs for the burial of royalty are called
    Boro Budurs   Mounds   Pyramids   Scaffolds
33. The most important aid to man is thought to be
    fire   the telephone   money   the automobile
34. Alphabet writing is credited to the
    Chinese   Hebrews   Egyptians   Phoenicians
35. The evolution of man began
    during the last 1,000 years   during the last 2,000 years
    during the last 10,000 years   more than 10,000 years ago
36. The Algonquins live in
    adobe houses   bark cabins   tents   igloos
37. The culture of the Yaghans is
    similar to the Murngins   similar to the Waiwai
    similar to that of the Eskimos   similar to Cro-Magnons
38. Sioux Indians used rawhide to make bags known as
    cassava   teepees   parfleche   travois
39. Manufacturing by early man arose largely from
    trade schools   scientific experimenting
    the intuition of great men   accidental discovery
40. The Hopi Katchina Dolls represent the Spirit that brings
    evil   rain   sunshine   bison
41. Mayan Civilization flourished
    before Egyptian Civilization   after Iroquois Civilization
    before the height of Buddhism   after Roman Civilization
42. A V-shaped hand axe made by early man was the
    harpoon   assegai   coup-de-poing   spear
43. The greatest contribution of the ages to popular education was the invention of
    machinery   radio   printing   oil paints
44. The adobe house made of sun-dried brick is characteristic of the
    Navajos   Pueblos   Sioux   Algonquins
45. The passing of a nomadic life permitted
    more travelling   less community life
    less time for basket making   the domestication of plants and animals
46. The mammoth is believed to be the ancestor of the
    reindeer   rhinoceros   bison   elephant
47. Tools were used
    before writing was invented   after cloth was invented
    after agriculture was common   after pottery was invented

48. The New Stone Age or Age of Polished Stone is the period known as
    Paleolithic   Neolithic   Neanderthal   Pleistocene
49. One of the first countries to enter the historic period was
    the United States   Egypt   Spain   England
50. The writing of the early Egyptians was
    ideographic   phonetic   cuneiform   pictographic